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GOOD WORK AT THE MINTS.

THE annual assay at the Mint at Philadelphia was finished Feb. 13, the number of coins tested being greater than ever before. The Commissioners examined coins as follows: From the Philadelphia Mint, $5,984 in silver and $413,812 in gold; San Francisco Mint, $46,995 in silver and $36,302 in gold; Carson City Mint, $1,313 in silver and $370 in gold. In the Philadelphia Mint double eagles, the average weighed was ·004 light; in eagles the variation was ·0025, and in dollars ·005, all being light. The average variation from the standard was less than one hundredth of the allowance. The trade dollar was correct, but the standard dollar was a quarter of a hundredth part over. The extreme variation from the standard in gold coins was in the San Francisco double eagle, it being ·007 light, and from the same mint the dollars were ·01325 heavy. The half dollars of the Philadelphia Mint showed the greatest variation, and were ·009 light. The quarter dollars, which showed the least variation, were ·052 heavy. The half eagles were ·071 light, and the three dollar pieces ·024 light. The greatest variation in gold coins was found in those from San Francisco, which were ·152 light. Those from Carson City were ·131 light. The variation in half eagles was only ·006 light from these mints, and they were ahead of Philadelphia in these coins.

THE EARNINGS OF THE WORKING CLASSES.

PROFESSOR LEONE LEVI, at the request of Mr. M. T. Bass, M.P., has prepared an estimate of the present earnings of the working classes in the United Kingdom, similar to that compiled at the same solicitation in 1866. The prevailing distress and the critical condition of the working classes at present have led Mr. Bass to believe that such an investigation as this may be peculiarly interesting and useful. Professor Leone Levi says that the population of the United Kingdom, which in 1871 was 31,513,000, has increased by 7 per cent., and is now 33,799,000. The number of persons engaged in various industries is a total of 11,509,000, composed of 7,821,000 men, and 3,688,000 women. Domestic service, the textile manufactures, and agriculture employ 90 per cent. of all women engaged in industry; 6,647,000 of all the men engaged in industry are occupied in agricultural and industrial pursuits. Quoting a great number of returns giving the wages earned in different occupations, Professor Leone Levi calculates the average rates of wages in the most skilled arts at 33s. and 35s. per week. It is, he says, in the nature of British industry, which consists mainly in manufactured goods and artistic products, to require much labor, and hence the greater conflicts between capital and labor in England than in other countries. The total amount of gross earnings of the working classes of the United Kingdom under a condition of an average amount of employment, and at present rates, he has ascertained to be £503,000,000, of which men earn £390,000,000, and women, £113,000,000. Deducting from this calculation 7½ per cent. for holidays and other suspensions of labor, estimated at four weeks' duration, and 2½ for the number of masters not distinguished in the census, a total of £452,700,000 remains. But another important deduction has to be made in consequence of the stagnation of trade, which has hitherto existed mainly in the textile industries, mining and metal manufactures, and that class of laborers of an indefinite character who are always the first to suffer when work is slack. He estimates the total number engaged, as here stated, at 4,239,000, earning £182,000,000. Allowing for a loss of wages in these industries to the extent of two months' additional, equal to one-sixth of the yearly income, amounting in all to about £30,000,000, the earnings of the laboring classes will be reduced to £422,700,000, an amount almost equal to that of 1866, divided, however, among a much larger number of laborers. The average wages show an increase, as compared with 1866, of 6 2·3 per cent. earned by men under 20; of 6¼, by men at and above 20; of 12, by women under 20; of 24, by women at and above 20. It will be seen, therefore, that women's wages have advanced more in proportion than men's, this being especially the case among domestic servants and dressmakers. Taken separately the average wages are not high, but, if the total amount earned be divided among the 4,800,000 families, each of five individuals, representing 24,000,000 as the number of the laboring classes, the amount per family will be £94 per annum, without the deduction for the depression of trade, and £88 with the deduction, 30s. per week in the first case, 33s. in the latter. Professor Levi says that in the past twelve years our laboring classes have had opportunities of setting aside a considerable amount, and there ought, therefore, to be no reason for the excessive distress complained of at this moment. In 1866 the total amount in trustee and post office savings banks was £44,503,000; in 1877 it was £72,980,000, being an increase of £28,477,000. The amount held by friendly societies in 1865 was £5,362,000; in 1874, it was £9,038,000, an increase of £3,676,000, making a total increase of both savings banks and friendly societies in ten years of £32,113,000, or an average of £3,200,000 per annum. But, says the Professor, a considerable proportion of the extra amount earned has been spent in an excessive expenditure for eating, drinking, and smoking. In no other country, he says, are the wages more liberal, but in no other country are they more wastefully used. The consumption of imported articles of food and drink per head in 1866 and 1867 shows a large increase for the latter year. In 1866 the percentage of bacon and ham consumed per head was 2·13; in 1877 it was 8·04, being an increase of 2·7; wheat and flour (lbs.) in 1866 was 104·50; in 1877 it was 203·26, being an increase of ·94, and so in proportion with such articles as sugar, tea, spirits, and malt.

THE INTERNATIONAL EXHIBITION BUILDING, SYDNEY, AUSTRALIA. TO BE OPENED OCTOBER 1st, 1879.

THE INTERNATIONAL EXHIBITION OF NEW SOUTH WALES.

THE Government of New South Wales has assumed the responsibility of carrying out the details in connection with the International Exhibition of 1879. Parliament has voted a sum of £50,000, which may be regarded as an installment for building purposes, and now the contractors are busily engaged in carrying out the work. The space provided in the main building covers an area of 4¾ acres, or 210,000 square feet, on the main floor, with a basement of 1½ acre, equal to 72,500 square feet, along the main front, and running the entire length and about one-third of the depth of the building. The gallery space will give an addition of 51,250 feet superficial, and a large amount of valuable wall space; the ground-floor refreshment rooms will contain an additional 5,000 square feet, forming a grand total of nearly 340,000 square feet in the main building—over one-third of the size of the first great Exhibition of 1851 in London. Applications for space are pouring in from all quarters.

The builders and contractors are working vigorously, and by the 1st of June the ground floor will be available for the reception of exhibits, but the Exhibition will not be opened until, say, the 1st October. All the Australian colonies will be represented, and it will be a great success.

DAIRY COTTAGE.

THIS dairy cottage is now being built for Thos. Middleton Howells, Esq., from the design of Messrs. Treasure & Son, of Shrewsbury. It is of brick walling generally, with oak framing externally, except chimney bases and lower portion of porch and bay window, which are of Grinshill red and white rubble random stone; panels between framing are cemented, and chimney stacks are of brown Broseley bricks, the roof being covered with brown or dark strawberry-colored Broseley tiles, with red ridge cresting. All wood framing painted black, and panels white.—*Building News.*

ZINC-DUST AS A CAUSE OF FIRES.

A RECENT issue of the *Insurance Record* calls attention to the dangerous character of zinc-dust, which appears to be imported into this country in considerable quantities for use in certain branches of industry. The material presents the appearance of a gray powder, in an extremely fine state of division, and its use appears to be in the manufacture of paints. Chemically, it contains as much as forty per cent. of metallic zinc-dust, the remainder being oxide and carbonate. Another variety of the same commodity, known commercially as slate-colored zinc oxide, contains really very little or no oxide at all, being almost wholly a metallic dust, which in the process of manufacturing zinc-white, has escaped combustion, and is deposited in the flues of the condensing apparatus. These products, the *Insurance Record* points out, are extremely apt to cause mysterious fires, if precautions are not taken to keep them from contact with moisture; for, owing to its very fine state of division, this metallic dust, in the presence of moisture, will eagerly oxidize, and as this oxidation will be attended with a very considerable rise in temperature, the hydrogen gas evolved in the process may be inflamed, and, directly or indirectly, inflammable materials in the neighborhood may be ignited, and in this way the building or ship in which it happens to be stored may be destroyed, while the cause of the disaster may never be suspected. The *Record* points its moral by citing the case of the fire in the steamship Lord Clyde, in the year 1876, which at the time attracted some attention. The facts in this case were about as follows: A number of casks of zinc-dust were placed in the hold of the vessel, without any notice of the dangerous character of the material having been given to the owners of the ship. The casks, or some of them, by some means got wet, and within twelve hours after they had been put on board, the vessel was found to be on fire. When the source of the fire was discovered, the contents of one of the casks was found to be red-hot. As another contribution to the causation of what, for want of a better term, are called "spontaneous" fires, the facts above detailed are worthy of special attention.

HEAVY ORDNANCE.

AT a recent meeting of the Institution of Civil Engineers, London, the paper read was on "The Construction of Heavy Ordnance," by Mr. J. A. Longridge, M. Inst. C. E.

Nineteen years ago the same subject had been brought before the Institution by the author. In the present communication he proposed to examine the progress since made in gun construction at Woolwich, and especially referred to the official "Treatise on the Construction of Ordnance," printed by order of the Secretary of State for War, in 1877. After pointing out that, in this treatise, it was admitted that the true law of the distribution of tension was unknown to the Woolwich constructors, the author showed that the system adopted by them, and known as the Fraser system, was not based on scientific principles, and led to results both costly and unreliable. The true law connecting the pressures with the tensions was then demonstrated, first, in a homogeneous gun, and secondly, in a gun built up on the model of the 9-inch Woolwich gun (Mark III.), consisting of a steel tube and a thick iron jacket. It was shown by detailed calculations that, assuming an internal pressure of 24 tons per square inch, the inner surface of the iron jacket would be strained to about 17 tons per square inch, or 7 tons above the elastic limit of the material. This was with a shrinkage of $\frac{1}{1000}$th of the diameter. A table was next given of the tensions of the iron jacket and steel tube due to an alteration in the shrinkage; and in another table, the author showed the variation caused by a change in the moduli of elasticity of the material. Assuming a shrinkage of $\frac{1}{1000}$th of the diameter, and moduli of elasticity of 12,700 tons for iron, and of 13,330 tons for steel, the result of repeated firing on the 9-inch Woolwich gun was investigated, from which it appeared that the effect was gradually to reduce the tensions of the iron jacket, and increase those of the steel tube, until finally the shrinkage was reduced to zero, and the gun became nearly a homogeneous gun. Under these circumstances it was shown that, while the whole bursting strain to be resisted, with an internal pressure of 24 tons per square inch, amounted to 108 tons, the steel tube of 3⅝ inches thick supported 52 tons, and the iron jacket of 12 inches thick only 56 tons. Also, that the steel tube was strained to 27 tons per square inch at the inner surface or 12 tons beyond its elastic limit. As a consequence, permanent set took place, increasing with each successive firing, and finally the gun failed by the cracking of the steel tube. A similar investigation respecting the 81-ton gun showed that a like result would ensue.

The author next gave the dimensions of a gun, built according to the true law, of the same caliber as the 81-ton gun, and showed that in it no portion of the material could ever be strained beyond 10 tons per square inch, with an internal pressure of 24 tons per square inch. After a few remarks on the combination of the longitudinal strain with the circumferential strain during explosion, the author described various types of heavy guns proposed to be built on the system advocated by him in 1860. Those types were:

1. A muzzle-loading gun of 20-inch caliber, weighing 150 tons, recoiling on its carriage. This gun would be 30 feet long in the chase, and would throw a solid shot of 3,000 pounds with a muzzle velocity of 1,600 feet per second.

2. A muzzle loading 13-inch gun, mounted on an ordinary gun-carriage.

3. A breech-loading 13-inch gun, weighing about 45½ tons.

In conclusion, the author pointed out the great difference in cost between guns thus constructed and the Woolwich guns. In the Blue Book, entitled "Army Manufactory Establishments," printed on the 8th of April, 1878, the cost at Woolwich was given as follows:

	Per ton.
10-inch guns of 18 tons	£74
11 " 25 "	80
12½ " 38 "	90

At the same rate of increase a 150-ton gun would not cost less than £180 per ton. By the author's system the cost of

	Per ton.
A 150-ton gun would not exceed	£35
A 13-inch muzzle-loading gun	32
And a 13-inch breech-loading gun	50

Photo-Lithographed & Printed by James Akerman, 6, Queen Square, W.C.

SUGGESTIONS IN RURAL ARCHITECTURE.—A DAIRY COTTAGE.

MODERN MUSKETRY.

WHILE we have been satisfied with the rapidly-firing breechloader, carrying but one cartridge at a time, no less than four foreign governments, including France and Austria, have been experimenting very seriously upon magazine or "repeating" rifles. The French have adopted for their navy the Kropatschek, an Austrian invention, weighing, without bayonet, 10 lb. 3 oz. unloaded, and 10 lb. 15 oz. loaded with eight cartridges. It, as well as the other magazine rifles experimented upon, can be used as an ordinary breechloader, and the experiments went to show that when rapidity of fire was necessary the Kropatschek and American rifle, the Hotchkiss, could be fired as repeaters not very far from twice as quickly as when they were used as ordinary breechloaders. It certainly seems of the highest importance that our War Office should, without delay, proceed to investigate the question of magazine or repeating rifles. The French navy are already armed with such weapons, the Swiss infantry use nothing else, the Austrians and the Norwegians have given them to a part of their army, and the Turkish cavalry have got them. We might as well begin to look into the nature of the new invention. It seems to us, indeed, that modern musketry is making such strides that there will soon be a place in warfare for every form of "handgonne," and for every method of using it. Infantry (and indeed cavalry) must be trained to use long-range fire both for attack and defense. Individual marksmen, perhaps with match rifles and telescope sights, will be invaluable for silencing field batteries, and when the pinch comes the rattle of the magazine guns may give the victory to those who possess them, and know how to use them with effect. Let us hope that the drill book will be revised in accordance with the new state of affairs, and that the authorities will take care that our soldiers are not left without ammunition when it may be their duty to spend and spare not.—*Volunteer Service Gazette.*

UTILIZATION OF SLAG.

As about 30 cwt. of slag are made for every ton of pig iron, the importance of utilizing this waste product is very obvious. In England, slag has been turned to account in the formation of breakwaters, such as that at the mouth of the Tees. Bricks, paving sets, concrete, and other articles are also made of it. Three millions of slag bricks, most of which go to London, are manufactured annually. Glass-works are now in operation at the blast furnaces in Northamptonshire, where the slag is run direct from the iron furnaces into the glass furnaces, mixed with other materials, and converted into glass for bottles, etc.

PROGRESS OF GERMAN CUTLERY.

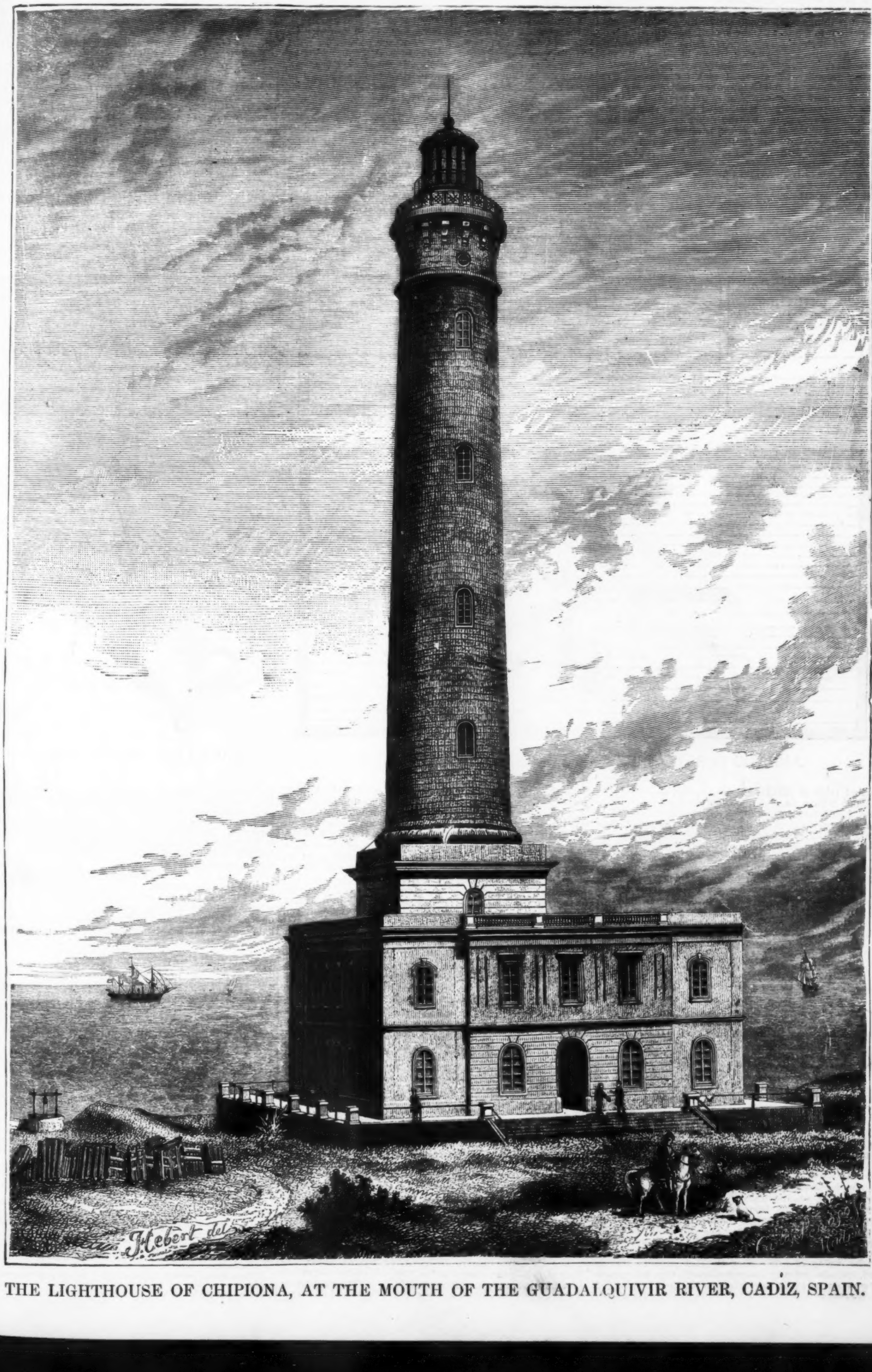
LARGE consignments of German cutlery and hardware, manufactured by G. D. Schaef, of Solingen, have reached England, and some of them have arrived at Sheffield, where they have produced no little excitement. The goods for the most part are exceptionally fine, and the prices remarkably low. Tailors' scissors, for example, cutting true from heel to toe, were offered at half the local price, and the Sheffield men themselves conceded that the get-up and finish equaled any of their own make. The cheapness of spring cutlery and "Lancashire goods," so-called, was startling. Four-blade knives, with pearl handles, were offered at 6 shillings 6 pence a dozen; braces and bits at half the usual price; small hand vises at 8 shillings a dozen; hinges at 5½ pence a dozen, and pliers and compasses at equally low rates.

THE LIGHTHOUSE OF CHIPIONA, CADIZ, SPAIN.

THIS splendid light stands at the mouth of the Guadalquiver river, coast of Chipiona, province of Cadiz, Spain, above the reef known as the Dog. Longitude 0° 14' 30" West, and 36° 44' 15" North latitude. It is a catadioptric light of the first order, white light, flashing once a minute, visible twenty-three miles. Its height is 225 feet above the level of the sea. The shaft is slightly conical, representing a column with pedestal, which forms the residence of the keepers. It was built in 1867, at a cost of $85,000, by James Font, C.E. Our engraving is from *La Ilustracion Española y Americana*.

THE DE BAY PROPELLER.

IN 1876 Mr. C. S. De Bay, of 9 Westminster Chambers, Victoria street, patented a propeller of very peculiar construction. He arrived at the form of this propeller by an elaborate mathematical investigation of the action of screws on water, which it is not necessary to reproduce. The propeller itself is illustrated by Fig. 4, next page. It is by no means easy to give a fair idea of its construction by a drawing. It consists of two screws of the same pitch, one, the larger, with four, and the other with five blades. Portions of the blades of each are cut out. The screws are fixed on two shafts, one tubular, the other solid, and rotating within



THE LIGHTHOUSE OF CHIPIONA, AT THE MOUTH OF THE GUADALQUIVIR RIVER, CADIZ, SPAIN.

it. By suitable mechanism the screws are made to revolve in opposite directions, the solid portions of each blade of one screw passing through the gaps cut out in the other, and *vice versa*. When a single screw is used in the ordinary way the water is caused to revolve with the screw to some extent, and consequently tends to fly off at a tangent all round, in a way well understood. The action of the screw also diverts the column of water driven astern from a line parallel with the keel to one at an angle with it, and as a result all screw ships carry a port or starboard helm, according as the screw is right or left handed. We have repeatedly enunciated the primary truth that that propeller is the best which—other things being equal—drives the greatest weight of water astern in a line with the keel of the ship to be put in motion, and at the lowest velocity. It is evident that the ordinary screw driving water astern not in a line with the keel, and also dispersing it tangentially, wastes power. In the De Bay propeller, the action of each screw neutralizes all other actions of its fellow save one; that is to say, the water is not caused to rotate, because the tendency to rotation caused by one screw is neutralized by the similar but opposing tendency set up by the other screw. In like manner the influence of one screw tending to deflect the water moving astern to the right, is counteracted by the other screw, which tends to send it to the left. The result is that the water can only be driven astern by the screws, and moves very nearly in a right line parallel with the keel. These are Mr. De Bay's arguments, and the results obtained in practice support them.

will be seen that the outer portions of the blades of the larger of the two screws appear to be very weak. Now, the Elaine had a very rough passage; but the propeller was not bent or injured in the slightest degree, and her voyage compared very favorably with the ordinary trips.

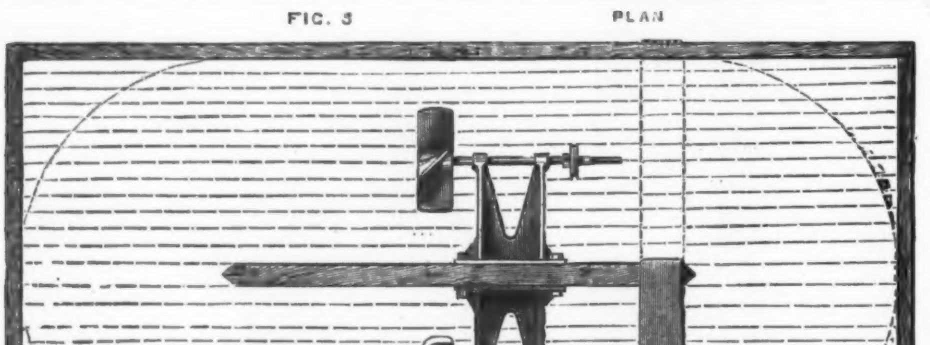
Although we were willing to admit that Mr. De Bay's propeller probably possessed certain advantages over the ordinary screw, we also held that the inventor attached an exaggerated value to these advantages; that, in a word, he over-estimated them. A little reflection will show that, other things being equal, that propeller is the best which exerts the greatest thrust, for the work of a propeller begins and ends with the development of thrust. Accordingly it was decided that a De Bay propeller should be tested on this basis against any normal screw which possessed a good character. It is extremely difficult to carry out tests of this kind on board ship. Mr. Froude, however, has shown that, with certain precautions, models may be made to give results which are quite sufficient for the purposes of comparison. It was determined, therefore, that the experiment should be made with models.

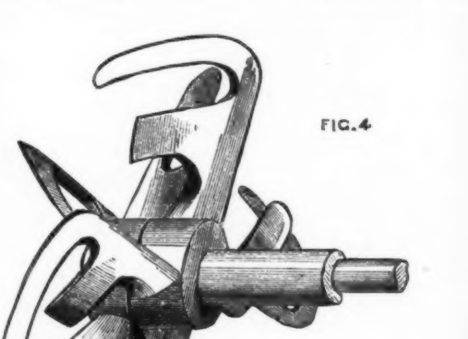
To this end the apparatus shown on this page was constructed by Mr. C. Berthon, of Westminster. It consists of a wooden tank, Figs. 1, 2, and 3, capable of holding about 100 gallons of water. Down the middle of the tank is fixed a partition, and to each side of the partition are bolted two similar cast iron brackets, bored to receive the screw shafts. This will be understood in a moment from the plan. On the top of the partition is mounted a roller revolving in between them, to ascertain approximately the amount of friction of each propeller. To this end the De Bay propeller was first driven, the tank being empty. A weight of 3 pounds 2 ounces was selected after several trials, ten runs were made, and the mean time occupied by the weight in falling 45 feet was 23·1 seconds. This represents 365·28 foot-pounds per minute.

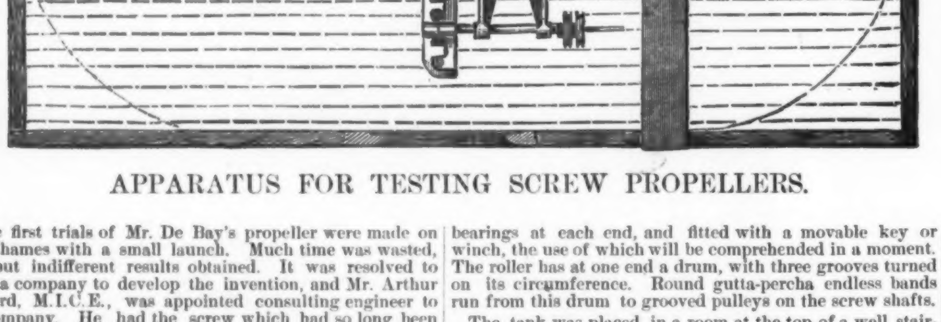
The screw chosen to compete with the De Bay propeller was a four-bladed Griffiths*, a very close model of the screw of H. M. S. Lord Warden. It is evident that the experiments of this kind might be extended over months, or even years, by using a sufficient number of propellers; but it was agreed on all sides that a good Griffiths screw might be regarded as a type of the best normal propeller that could be got; and to simplify matters but the one propeller was used. It is illustrated by the cut below.

This screw was driven in air by a weight of 1 pound 14 ounces. A mean of ten runs gave the time of descent as 16·5 seconds† per 45 feet, and 306·8 foot-pounds. It would have been better had the velocities during these experiments been more nearly alike; but it was found that with a less weight than 1 pound 14 ounces it was impossible to secure as much uniformity in the time of descent as was desirable, the friction nearly balancing the pull of the weight. The broad fact was proved that the frictional resistance of the De Bay propeller was in the experimental apparatus much greater than that of the simple screw, and this sufficed for the purpose of the inquiry.

The tank being filled up with water, the De Bay propeller







APPARATUS FOR TESTING SCREW PROPELLERS.

DE BAY'S PROPELLER.

The first trials of Mr. De Bay's propeller were made on the Thames with a small launch. Much time was wasted, and but indifferent results obtained. It was resolved to form a company to develop the invention, and Mr. Arthur Folkard, M.I.C.E., was appointed consulting engineer to the company. He had the screw which had so long been tried in the launch replaced with one of a different pitch, and very soon obtained highly encouraging results. It was obvious, however, from the first, that sufficient information could not be obtained from so small a craft, and therefore the company chartered a large screw collier—the Elaine—wherewith to make further experiments. This vessel had had several alterations made in her screw, and was believed to be fitted with that which best suited her. She was taken

FIG. 5.—GRIFFITHS SCREW.

down to the Maplin sands last summer, and a series of runs were made with her to ascertain what was her best performance with the normal screw. These concluded, she was sent to the North, and fitted with a De Bay screw. Much delay was incurred, and when she was at last dispatched for London the gearing was very imperfect, and worked so badly that it would have been impossible to make an accurate comparison between the performance of the De Bay and the normal propeller. The ship could no longer be spared from her regular duties. The season was far advanced, and it was resolved to postpone all further trials until the spring of 1879. The De Bay propeller was removed, and the ordinary screw replaced. One thing, however, was proved by her trip from the North to London. It

bearings at each end, and fitted with a movable key or winch, the use of which will be comprehended in a moment. The roller has at one end a drum, with three grooves turned on its circumference. Round gutta-percha endless bands run from this drum to grooved pulleys on the screw shafts.

The tank was placed in a room at the top of a well staircase, and to the ceiling over this well was secured a pulley; a stout deep-sea fishing line was reeved through this pulley. One end was secured to the barrel at A, to the other end was hooked a suitable bag, which could be loaded with shot to any required weight. This bag descended in the staircase well—a height of about 45 feet being available—and in running down it caused the barrel, A, to revolve, and with it either or both of the propellers to be tested. As each propeller was run separately, it put the water in the tank in motion. A thin curved plate of iron deflected the current; and the conditions were on the whole not much unlike those which would have obtained had the screw advanced through still water, instead of the water flowing past it. The thrust was, however, reduced.

In order to ascertain the thrust, a bell-crank lever was provided. This lever turned freely on a small pin on a wrought iron bracket bolted to a board, which could be screwed down across the tank at either side of the partition, as shown by the dotted lines in the plan. At the end of the vertical arm was a small smooth horizontal point, which entered the lathe center made in the end of the propeller shaft. The shafts were of course free to slide on their bearings in the cast iron brackets. The thrust was measured by a weight placed on the horizontal arm of the lever. The weight employed in all the experiments was 10·25 ounces. The length of the vertical leg of the lever was precisely 10 inches, and the thrust was obtained by multiplying 10·25 ounces by the distance between the point of suspension of this weight and the pin on which the lever turned, and pointing off the last figure. In testing the apparatus, a given weight was placed in the bag, the line was coiled up on the roller by the aid of the winch handle, which was then removed. All being ready, at a given signal the roller was released, and the weight permitted to descend. The time of its descent was taken with a stop-watch. Ten runs were made for each experiment, and a mean obtained from them. The results as a whole were remarkably uniform.

The De Bay propeller being driven by two cords, one crossed, while the simple screw was driven by but one, it became necessary, in order to establish a fair comparison was run, the Griffiths propeller being put out of action by throwing off its driving cord. In order to utilize the whole fall available it was necessary to wind the cord twice on the barrel, and thus to vary the diameter of the barrel during each run. As this was objectionable, in all the runs made in the water the cord was coiled once on the barrel, and the fall was 21·75 feet and 21·83 feet for the De Bay and Griffiths screws respectively.

We have put the more important figures in the annexed tabular form for comparison, and on examining these figures it will be seen that an expenditure of 263·25 foot pounds per minute with the De Bay propeller gave a thrust of 16·40 ounces. In like manner the Griffiths propeller, with an expenditure of 314 foot-pounds per minute, gave a thrust of 14·86 ounces:

GRIFFITHS SCREW.

Diameter.	Diameter at stated pitch.	Pitch.	Total area of blades.	Thrust in ounces.	Foot pounds per minute.
$7\frac{9}{16}$in.	4in.	21·67in.	1416‡	14·86	314·09
		De Bay	*Propeller.*		
$6\frac{7}{8}$in.	4in.	13·062in.	1468‡	16·40	263·25

The relative efficiency of the two screws may be compared in various ways. The simplest and most obvious method of showing it is by giving the thrust per foot pound of work done on the screws. The De Bay propeller exerted a thrust of ·00389 pound, and the Griffiths screw a thrust of ·00295 pound per foot pound of work done, from which it appears that the efficiency of the Griffiths screw being taken as 100, that of its rival was 131·8; or taking the De Bay propeller as having an efficiency of 100, then that of the Griffiths screw

* A four-bladed common screw was first tried, but its performance was so bad that it was rejected the first day.

† It will be understood that although only ten runs have been used for the purpose of calculations, a much greater number were actually made, numerous preliminary runs being used as a precaution, and to insure the accurate working of the apparatus. In many instances there was not a greater difference than one second between the times of as many as ten or a dozen runs.

‡ These figures are only intended to give the comparative areas of the screw.

was only 75·8. But these calculations are based on the assumption that the friction was the same for both screws. Now, as a matter of fact, the net power available for the production of useful effect was, in the case of the De Bay propeller, less than in that of its rival. Making a moderate allowance for this, we shall not exaggerate if we say that the De Bay propeller is at least 40 per cent. better than the Griffiths screw.

We may consider the relative performance of the two propellers from another point of view. The pitch of the De Bay propeller is in round numbers 13 inches, and it made 65·1* revolutions per minute. If we suppose that it had been driving a ship without slip, and that for inches we substitute feet, then the ship would have advanced 65·1 × 13 = 846·3 feet per minute. Calling the foot-pounds horse power, we could have, let us suppose, this rate of advance for 263·25 indicated horse power.

Now, had the Griffiths screw been fitted to the same ship, we should have had smaller thrust in the ratio of 14·8 to 16·4. The speed of a ship depends not on the pitch of the screw but on the thrust, and it will vary approximately in the ratio of the square roots of the thrust; consequently, the speed of the ship with the Griffiths propeller, instead of being 846·3 feet, would have been 827·01 only. But the pitch of the Griffiths propeller is 21·6 inches, and its revolutions per minute were as nearly as may be 77; consequently had the ship progressed as fast as the screw the speed would have been 1733·6 feet per minute, instead of 837·01, which, the speed of the screw to the contrary notwithstanding, is the utmost it could have been. It thus appears that under the conditions the slip of a Griffiths screw would have been considerably over 50 per cent.

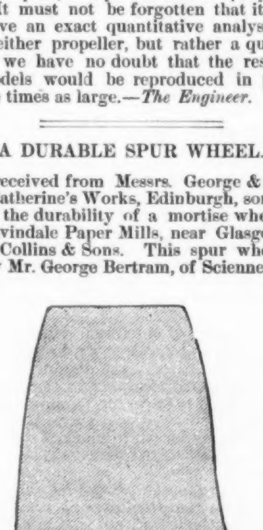
It will be argued, and justly, that a Griffiths screw, with a slip of 50 per cent., could not have been suitable to its intended purpose, and that by using a screw of different proportions a different result might be obtained. This we willingly admit, yet it is also evident that to get increased thrust without augmenting the velocity, the area of the blades of the propeller must be increased. But it will be seen that the model Griffiths screw was larger than the De Bay propeller already, and thus, according to the experiments in question, it seems that a De Bay propeller, much smaller in diameter than an ordinary screw, may be used to obtain the same results. This bears out the conclusions arrived at by Mr. De Bay, from the mathematical investigations to which we have already alluded.

An inspection of the action of the two models in water left no doubt as to the cause of the great discrepancy between their performances. The Griffiths propeller threw up a considerable wave, and directed the current against the side of the tank. The action of the De Bay propeller was entirely different. It threw up no wave. On the contrary, after it had been a few seconds at work, a vortex was established over it, down which the water descended rapidly to the center of the propeller. By the use of small pieces of paper—which when wetted remained almost indifferently at any depth in the water—it was rendered clear that water, instead of being driven off tangentially, *was drawn in at all sides of the propeller and thence driven astern*. This action we have never before seen produced by any screw. The two propellers were in one experiment both driven at the same time, and of course at the same velocity. The result was that the current put in motion by the De Bay propeller was driven right round the end of the partition into the Griffiths compartment.

Were space available we could supply details of the precautions used to obtain accurate results, but our readers must take it for granted that due care was used. Mr. Folkard watched all the trials on the part of the De Bay Propeller Company. The apparatus, albeit not burdened with minute mechanical refinements, was quite sufficient for its intended purpose, and placed neither propeller at a disadvantage. It must not be forgotten that it was not constructed to give an exact quantitative analysis of the performance of either propeller, but rather a qualitative comparison; and we have no doubt that the results obtained with the models would be reproduced in practice with screws twelve times as large.—*The Engineer.*

A DURABLE SPUR WHEEL.

WE have received from Messrs. George & William Bertram, of St. Catherine's Works, Edinburgh, some interesting particulars of the durability of a mortise wheel now working at the Kelvindale Paper Mills, near Glasgow, belonging to Messrs. E. Collins & Sons. This spur wheel was made and geared by Mr. George Bertram, of Sciennes, Edinburgh,



and set to work in 1851; it having now been running 26½ years, day and night, and during the whole of that time not a cog having been touched. Latterly the wheel began to get off pitch, or otherwise it might have gone on longer; under the circumstances, however, it was considered unwise to permit this.

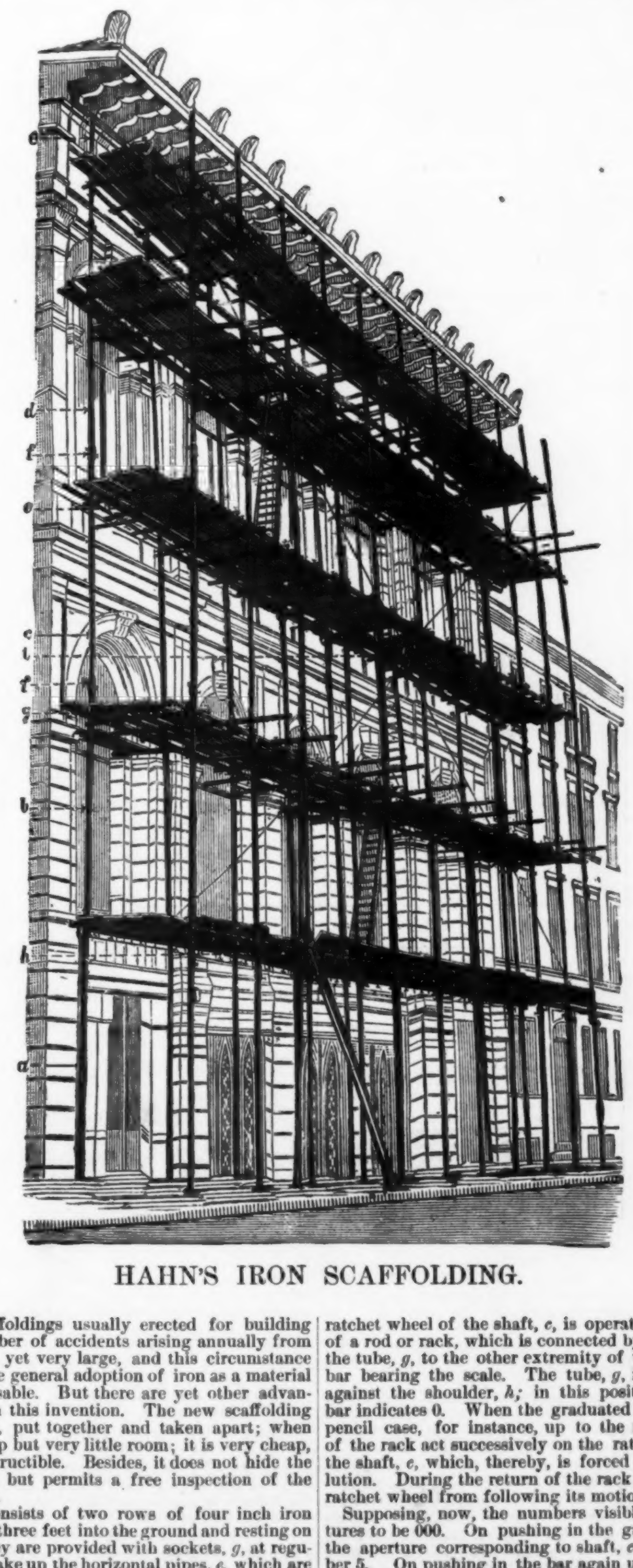
The wheel, which is 14 ft. ½ in. in diameter at pitch line and 10 in. wide on the face, is fixed on the crankshaft of a beam engine, and has run at an average speed of 38 revolutions per minute, the speed during the latter half of the period it has been at work being, however, 45 revolutions per minute. The wheel drives a machine-dressed pinion 4 ft. in diameter with 50 teeth; and the power developed by the engine is from 90 to 100 indicated horse power. From a half-cog with which we have been favored by Messrs. Bertram, we have prepared the annexed fac-simile of the present shape of the teeth, showing the amount of wear.

Taking the speed of the pitch line as 5,886 ft. per minute, and the mean horse power transmitted as 84 (being the indicated power of the engine less engine friction), we get $\frac{33{,}000 \times 84}{5{,}886 \times 10} = 47{\cdot}1$ as the average pressure on the teeth per inch of width. Taking the working days at 283 per year, thus allowing a large margin for stoppages and Sundays, and only 20 working hours per day, the cog we have received has traveled not less than 2,900,000 miles, or fully 118 times round the circumference of the globe. The beech from which these cogs were made was grown in Midlothian, and they were greased twice a week, tallow and lead ore being the lubricant used. The half-cog we have received shows very uniform wear throughout its width, the surface being very smooth and there being no signs of scoring. Altogether the performance of the wheel is of much interest.—*Engineering.*

* The speeds employed were, it will be seen, much less than it has been the practice hitherto to adopt with models. It is believed, however, that much more accurate results can be thus obtained than with speeds of, say, 300 or more revolutions per minute. Sixty to seventy revolutions per minute is a very common velocity for screw propellers in the mercantile marine, and feet may be substituted for inches for the purpose of comparison, as will be seen further on, with much ease when the propellers make about an ordinary number of revolutions. At higher speeds models produce much splashing unless they are very deeply immersed, and there is every reason to believe that the higher the velocity the more favorably would the De Bay propeller have compared with that of its rivals.

HAHN'S IRON SCAFFOLDING.

MR. MAX HAHN has invented a new scaffolding composed of iron pipes, which no doubt is superior in many respects to the old wooden scaffoldings usually erected for building purposes. The number of accidents arising annually from insecure scaffolds is yet very large, and this circumstance alone would make the general adoption of iron as a material for scaffoldings advisable. But there are yet other advantages connected with this invention. The new scaffolding is easily transported, put together and taken apart; when not in use it takes up but very little room; it is very cheap, as it is almost indestructible. Besides, it does not hide the building from view, but permits a free inspection of the progress of the work.



HAHN'S IRON SCAFFOLDING.

The scaffolding consists of two rows of four inch iron pipes, *a*, sunk about three feet into the ground and resting on pieces of board. They are provided with sockets, *g*, at regular intervals, which take up the horizontal pipes, *c*, which are three inches thick. They are firmly connected by cylindrical couplings, *f*, consisting of pieces of pipe strengthened at the ends by rings of wrought iron and fastened by screws.

The horizontal pipes are provided with holders receiving the puttocks, which are lastly placed in position. The thickness of the pipes varies for each story. While for the lower story four-inch pipes are used, those used for the fifth story only measure three inches. Two men can easily put up the entire scaffolding in less than a day. The area of cross section of the pipes may be one-third smaller than that of timber of corresponding strength, or, allowing the same dimensions, the strength and safety will be increased 33 per cent.

LEUNER'S ADDING PENCIL.

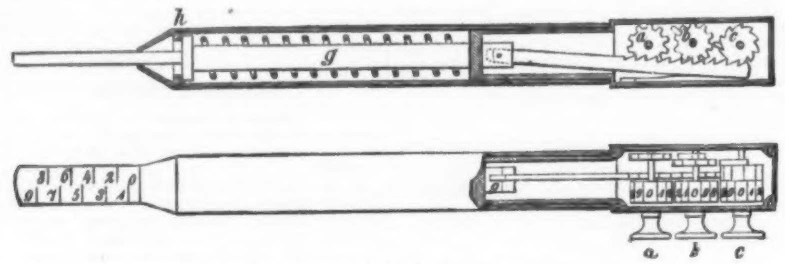
THE accompanying engraving illustrates a pencil patented recently by Mr. Oscar Leuner, by which any number of sums, amounting together to less than 1,000, may be added together.

From the lower, cylindrical portion of the pencil case a flat bar projects, bearing on one side a scale graduated from 0 to 9. To add a number, the pencil is pressed in slightly oblique position against the paper; the flat bar is hereby pushed back into the case up to the number desired to be added. As soon as the pressure on the pencil is released, the bar slides back into its original position.

The upper, rectangular portion of the pencil case contains three small steel shafts, *a*, *b*, and *c*. They are provided with small knobs, by means of which they may be adjusted. On each of these shafts revolves a drum, the surface of which also bears the numbers 0 to 9. In front of each drum the pencil case is provided with a small aperture, through which the numbers are visible in the respective positions of ones, tens, and hundreds. Besides the drums, the shafts are provided with ratchet wheels having ten teeth each. The ratchet wheel of the shaft, *c*, is operated upon by the teeth of a rod or rack, which is connected by means of a pin with the tube, *g*, to the other extremity of which is attached the bar bearing the scale. The tube, *g*, is forced by a spring against the shoulder, *h*; in this position the scale on the bar indicates 0. When the graduated bar is forced into the pencil case, for instance, up to the number 5, five teeth of the rack act successively on the ratchet wheel sitting on the shaft, *c*, which, thereby, is forced to make half a revolution. During the return of the rack a spring prevents the ratchet wheel from following its motion.

Supposing, now, the numbers visible in the three apertures to be 000. On pushing in the graduated bar up to 5, the aperture corresponding to shaft, *c*, will show the number 5. On pushing in the bar again up to the same point, the shaft, *c*, will complete its revolution and indicate again

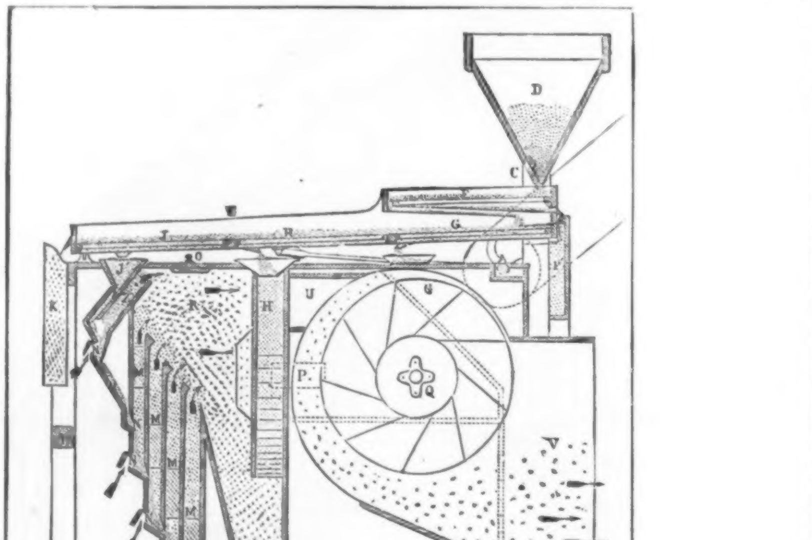
0. At this moment a cam attached to the shaft, *c*, acts on the wheel sitting on the shaft, *b*, turning it ahead one tooth. The aperture corresponding will now indicate 1. When the shaft, *b*, has made ten consecutive revolutions, it will again mark 0, while the aperture corresponding to the shaft, *a*, will mark 1, as the shaft, *b*, is also provided with a cam acting on the ratchet wheel sitting on the shaft, *a*. It will be seen that in this manner all numbers up to 999 may be readily obtained. The drums may be adjusted to indicate any number by means of the little knobs. It is obvious that, by increasing the number of drums, the capacity of the apparatus may be easily increased.—*Deutsche Gewerbe Zeitung.*



LEUNER'S ADDING PENCIL.

MILLOT'S GRAIN SEPARATOR AND GRADING MACHINE.

In the manufacture of flour the importance of a thorough cleaning of the material from which it is made, viz., wheat, is much more generally recognized in this country than was the case at one period. In order to obtain a high standard of quality in the manufactured article many things are required, but it is obvious that if the antecedent wheat cleaning processes are not attended to, the result of the best scientific milling will be more or less unsatisfactory. The improvement of wheat cleaning machinery to the highest possible pitch, from those used in the elementary processes for separating it from foreign matter to those employed in the more delicate operations which are used for the purpose of removing those organic parts of the berry itself, the admixture of which with the ground product would be more or less detrimental to the latter, is the leading object with milling engineers.



MILLOT'S GRAIN SEPARATOR AND GRADER.

A.—The driving pulley.
D.—The feed hopper.
C.—The feed regulator.
E.—The sifting apparatus, with four sieves provided with perforated zinc.
F.—The first sieve.
G.—The second sieve.
H.—The third sieve, leading to the channel H.
J.—The fourth sieve.
K.—Grain inlet to air channels.
L.—An oblique lying sieve, dividing the grains, so that the air currents may act upon all of them singly.
M M M M.—Air Channels for grading the grains according to their specific gravities.
N N N N N N.—Air inlets, regulated by valves.
O.—Air valve.
P.—Regulators for air currents.
Q.—Fan, constructed like a turbine.
R.—Condensation chamber, in which the light grains are sorted from the chaff.
S.—Outlet of cleaned wheat.
T.—Outlet for light grains.
U.—The channel through which the chaff is carried away, after being caught by the fan.
V.—The outlet of the chaff, whence it is conducted to the dust chamber.

Among the manufacturers of machines for wheat cleaning, M. Millot, of Zurich, holds a distinguished place, and to-day we give a description of a grain cleaning and separating machine, one of the latest of his construction. The machine is used in the elementary processes of grain cleaning, and it will be seen from a glance at our illustration that it belongs to the aspirating type in which air plays a prominent part both in the cleaning and separating operations. The machine occupies small floor space, and it is said that an expenditure of ¼ horse power cleans from 1,200 to 2,500 pounds of grain per hour. One of the advantages claimed for the machine is its simplicity of construction.

The grain is fed from the hopper on to the sifter, which consists of four sieves, covered with different Nos. of perforated metal. The fine dust passes through the first sieve, the smaller seeds that may be used as poultry or pigeon food pass through the second, rye seeds pass through the third, and the best grain through the fourth. Each variety of material runs through outlets adapted to their size and character in the machine, while stones are delivered at its tail end. The superior grain, after sizing, is exposed to a current of air, which sucks the lighter grain and impurities into a fan. The grain that has resisted the first separation falls into a receptacle, where it is subsequently separated according to the specific gravity of each grain. By the action of the fan the lighter grain is sucked into a special outlet, while the heavy grains are subjected to three or four additional separations. Simple means are provided for the admission of the air into the machine and the regulation of the strength of its currents upon the material. The driving pulley of the machine is 9½ inches diameter, and makes from 290 to 300 revolutions per minute. The extreme length of the machine is 5 feet 9 inches, width 3 feet 9 inches, and height 6 feet 11 inches.—*The Miller.*

THEORY AND PRACTICE IN BREAD MAKING.

By Mrs. Geo. M. Whitaker.

It has seemed in former years rather belittling to the women of Worcester South that they were thought either incompetent to judge of the work of their own hands or else too ignorant to state their views, that one of the superior (?) sex should be needed to cast his self-sufficient eye over articles of whose manufacture he knew nothing, or find language to express the decision of the real judges. If we are to be lectured so much about our sphere and the need of keeping ourselves within it let our instructors set the example. Man writing a report on bread or butter and talking about woman's sphere!

There is said to be a law among the Arabs permitting divorce for ignorance in bread making, and trivial as this failing may seem, it opens the way to ill health, ill temper, and in consequence, sin. A sound body is necessary to a sound mind, and those who have not these, in consequence of unassimilated food, are unable to think clearly, act kindly, or perfectly use their faculties and intelligence. Our lives to a great degree are in the hands of those who prepare our food, and it is much to be regretted that the preparation of it is often intrusted to those who know almost nothing about it, or who look upon cooking as of minor importance and something to which it is not essential to bring thought and education. But the fact is becoming recognized that to well fill the office of cook, either in one's own home or in public houses, requires attention to the subject before entering the mysteries of the culinary work. Already we hear of cooking schools in the larger cities; Miss Parloa has given lectures and taught classes in this State, and Miss Corson in New York, with better success than did Professor Blot some years ago, because his methods were too complicated for use in American homes.

The interest in the subject increases until, in the demand for more practical education, steps may be taken in this country toward public instruction in cookery, as has already been done by the London School Board. Until such a time, the training of girls at home under the guidance of their mothers must not be neglected, and this is the best method when the mother is a competent teacher; but it must be confessed that in too many cases even mothers show a lack of knowledge on this subject, and would be better scholars themselves than teachers. Girls learn to make cake and pastry; but plain bread, such as we eat three times a day, any one can make, is their apparent thought. No cook book recipe can entirely learn one how to make bread; the proportions may be given correctly, but the mixing, raising, and baking is a long process in which observation and experience are the teachers, to which it would be well to add a knowledge of the chemistry of bread making; then there would be less need of having "good or bad luck."

Bread, in some variety, forms the foundation for the food supply of nearly all mankind, because the grains are well fitted to be the food of man as regards nutrition and facility of preparation. The oaten cake of Scotland, the black bread of the Russians, the rice cake of the Chinese, the perfect French bread, as well as the hoe cake of the South, and the rye and Indian loaf of rural New England, all form a staple part of the food of their respective localities.

If it were possible to place in every home bread of the first quality, it would almost remove not only the national disease—dyspepsia—but also the cause for much intemperance. Strong drink has soothed the distress caused by ill cooked food in many stomachs, until it has become as essential as the food itself.

Wheat will sustain life longer than any other food excepting milk, because it contains within itself elements in the best proportions for the growth of bone, muscle, nerve, and flesh; hence, for bread making, wheat flour must rank first. It contains a greater per cent. of gluten, which is the element necessary to give it elasticity and a capability of being raised or aerated by fermentation or chemical substances. There are tests, which every experienced cook understands, by which to judge the quality of flour; it should not be lumpy and hard, neither should it be gritty, but such as pressed in the hand shows a light impression. The surest test is in the baking, and the skilled bread maker can tell in the early stages of the process whether the result will be satisfactory. Firm, elastic dough, rising above the edge of the bread bowl yet keeping itself upright, is a sign of good flour, but if the mixture runs over the edge or flattens in the center the flour must be condemned, provided all the other conditions have been right. There is, however, no lack of ignorance about these various conditions, for it is easy to mismanage good flour so as never to have good bread from it; it is possible for one cook to make excellent bread of flour from which another can never obtain a good result. Experience soon learns one how to treat the various kinds. Perfect bread is not the work of chance, but the direct results of certain chemical changes, and when these are once understood it is easy to see what to avoid to insure good success. To a few who are born cooks such care and foresight may not be necessary, but to most women there is no royal road to bread making, and the perfect loaf represents labor and skill.

The first requisite is good flour. That part of the wheat next the covering or husk is called the most nutritious, and in bolting some of this is lost, leaving, in consequence, a white flour at the expense of nutrition. This often serves as an argument for using second-rate flour, but we never saw the woman who refused the best and whitest flour she could get. It is the one who *buys* the flour who makes so much of the little nutriment that lies next the wheat hull. If our diet was bread alone there might be reason in saving this portion, but its loss is easily made up by the other articles of food. All cooks know that the best grade of flour makes the nicest bread, which is never a drug on the table, but poor flour is sure to be followed by scraps and crusts, which are wasted.

The most common way of raising bread is by yeast, which, added to the mixed dough, soon induces a fermentation by which carbonic acid gas is evolved. This gas is held by the tenacious gluten of the flour, and because of the large amount in wheat flour, we are able to raise it more than twice the original bulk. Good bread has passed through two stages of fermentation, the sweet and the vinous. The latter stage is well known by the agreeable odor; at that stage it must be checked (and right here are the majority of failures in bread making), or the third or sour fermentation will soon take place if the cook allows her attention to be divided; then recourse must be had to soda, which only partially remedies the fault, because it is not possible to know just how much to use. This will be the bread that it is a sin to put upon the table—it is as much like good bread as husks to corn.

Yeast, being a plant of the fungus tribe, is always essentially the same, but there are many rules for making it, differing mostly in the proportion of the ingredients. We notice when it is fresh, it is always in motion, and we speak of it as "lively." Malt, potatoes, and hops are commonly used in yeast; the hops to prevent souring, as they tend to check fermentation; potatoes hasten it, and are better left out in warm weather. Yeast mixed with meal and dried becomes the convenient yeast cake.

Leaven as an aid to fermentation is as old as the time of Moses, and we learn that the leavened bread of those days was not baked in a thick loaf, but in thin cakes, which were always broken. A piece of sour fermented dough, called leaven, added to the fresh dough, "leaveneth the whole." Bread raised by this means is apt to be sour, as the leaven generally induces sour fermentation, but in France, where it is much used, and the bread is of the best quality, they are skilled in the use of it and never allow it to reach the third stage of fermentation. It is a method little used in this country.

Another method of raising bread is the milk yeast, or "salt risings." Milk, flour, and salt are mixed in the proper quantities, and kept at the temperature necessary to develop the yeast plant, which is 90°; afterwards, sufficient flour is added to mix the bread, which, when baked, is light and very white, but it has an unsavory odor while making, and after it is a day or two old, which suggests that it may not be wholesome. Aerated bread is made without yeast or chemicals; carbonic acid gas added to the water with which the dough is mixed sufficiently inflates the bread. The whole process is done by machinery, and the method is impracticable for the housewife. In the accumulation of cares which modern times have brought into our homes, there is often a temptation to make use of means to lighten labor at the expense of the best results. Such an effort is never more misplaced than when soda, cream tartar, phosphate of lime, and other chemicals are made to take the place of good yeast. As a convenience, these articles may be used for making

bread to be eaten warm, and their limited use is not hurtful; but to take into the stomach daily as much of these materials as it is necessary to use in bread making cannot fail to injure the health. Self-raising flour can now be bought which only needs mixing with water, and the bread or biscuit is ready for the oven. The component parts of the "baking powders," added to the flour, do not act upon each other without moisture, and can be kept indefinitely in a dry place.

It is not long since these chemicals were in common use, and our ancestors used pearl ash, a substance so strong that it was difficult to use little enough of it. The ashes of burnt cobs dissolved in water well supplied the lack of pearl ash.

Hygienists have said much against the use of fermented bread; they represent our taste for it to be a morbid one, and that a large amount of sickness arises from it; that the original combination of elements in wheat flour is the most useful, and fermentation, or the first stage of decomposition, renders it unwholesome. This might be true of sour bread, or the baker's loaf that is raised very light, and by the addition of salt and alum made to take up water to increase its size until it is as substantial as air; but the sweet home-made loaf must be the standard bread; the infant and invalid, as well as the strong man, eat and digest such bread, which is more than can be said of the pastry gem, dry cracker, or any unleavened bread.

Having successfully prepared the bread for the oven, it may yet be rendered unfit for eating; too little heat, or less than 212°, will not kill the yeast plant and check the rising; more heat is required to bake the bread; too much will form a hard crust, leaving the inner portion uncooked and clammy. It is a common mistake to speak of stale bread as dry bread. New bread is nearly half water, and the loaf a week old has lost only about a hundredth part of its moisture.

Unbolted wheat finds favor with many, and bread made from it has a disputed reputation as a means of cure for dyspepsia and other ills. The flour is subject to adulteration, and however wholesome, when sweet and fresh, it often contains elements which are irritating to the digestive organs. If made from freshly ground meal or flour, the bread is an agreeable change from that made of white flour. Rye flour, formerly more used for bread than now, is not as good as wheat, owing to its tendency to sour; lacking the proper amount of gluten to make it rise well, it often makes heavy bread. Corn meal cannot be made into fermented bread without the addition of rye or wheat flour; and then it is but slightly raised; it can be made light with baking powders, if flour is added.—*Report Worcester South Agricultural Society.*

FRAUDULENT "GREENING" OF OYSTERS IN FRANCE.

THE fact is well known that the small copper-flavored oysters of Europe are much more esteemed and bring a higher price when they have a greenish tinge than when of their normal color. For this reason, says *Les Mondes*, the industry of "greening" oysters by an appropriate culture has long been carried on at Marennes and Ostend, the object being to develop in the mollusks certain nutritive qualities demanded by epicures, viz., plumpness, tenderness, and a very savory juiciness. To effect this the oysters, as soon as they are gathered, are placed in inclosures filled with sea water, and left there for several months, care being taken to renew the water only in very sparing quantities. At the end of this time they acquire that grayish-green color, which is only seen on the branchial folds, and which indicates that the time has arrived to deliver them for consumption. Many opinions have been put forth as to the reason for the change of color which takes place in the oysters under these conditions. Some have affirmed that it is due to the green algæ on which they feed, others that it is caused by the entrance into their respiratory apparatus of certain naviculæ, thus hindering their respiratory functions, and, finally, MM. Coste and Valenciennes assert that it is simply the sign of an affection of the liver caused by their sequestration in a confined place. However this may be, the best authorities agree that the coloration is provoked by a disease, and that it is accompanied by an increase of fatty cells which happily modify their nourishing properties. From the great demand for green oysters, then, it will be readily understood why certain dealers try to give different oysters this so much esteemed color, and that, too, by employing, not the method followed at Ostend and Marennes, but more rapid and profitable ones; and which, far from rendering them more succulent, communicate harmful properties to them. Dr. Jaillard, in the *Revue Bordelaise*, says that among these methods there is one much more dangerous than all others, and the attention of dealers should be directed thereto; it consists in immersing the mollusks in baths charged with a salt of copper, and leaving them in it until they are impregnated with the salt. Under these conditions they soon acquire the desired tint, and will keep it for a long time, as long, indeed, as they are kept plunged beneath the sea. Although this metallic color reminds one of that of verdigris, and differs from the genuine color, yet it readily deceives the unwary eye of the epicure, and constitutes an attempted fraud on the public health. Dr. Jaillard states that having been called on to examine some oysters out of a cargo that had arrived at Bordeaux under the name of "Portuguese oysters," he satisfied himself that they contained considerable quantities of copper. From analyses made by him it resulted that in a dozen oysters he found a quantity of copper equal to that found in 0·147 milligramme of blue vitriol, a quantity sufficient to cause distress and vomiting. Certain persons who had eaten only a half dozen of these oysters were taken with violent sickness at the stomach, and exhibited grave functional troubles—vomitings, diarrhea, and syncope, which, for a time, threatened serious consequences. The whole cargo was thereupon promptly destroyed by the city authorities.

METZGER'S IMPROVED MACHINERY FOR MANUFACTURING VERMICELLI AND MACARONI.

THE accompanying engravings illustrate some improved machinery for manufacturing macaroni and similar farinaceous articles of diet. These machines have been constructed by the Messrs. Ch. Metzger & Co., of Homburg, Germany.

Fig. 1 represents an apparatus for mixing the different articles entering into the composition of the dough. It consists of a sheet iron box, the upper portion of which is rectangular, while the bottom is rounded off cylindrically. Within it revolves an agitator, formed of a wrought iron shaft, to which are attached several iron skeleton blades, formed so as to traverse all the entire lower portion of the mixer once during one revolution.

The agitator is operated slowly by means of a large toothed wheel actuated by a cogwheel sitting on a shaft, the other extremity of which carries a pulley, to which power is transmitted by means of a belt. During work, the box is held firmly in vertical position. When the dough is sufficiently mixed, the agitator is stopped and the box turned around its axis to allow the dough to flow out.

The whole is supported by a stout cast iron frame.

The dough must now yet be kneaded for some time. The apparatus used for this purpose is represented by Fig. 3. It consists of a cast iron pan resting on a support of stone masonry, and measuring six feet in diameter. In its center there is fastened a conical block of cast iron, serving as a journal for a vertical shaft, the upper extremity of which is held in position by a cast iron frame secured to the woodwork of the ceiling. This shaft is caused to revolve by means of a belt, pulley, cam wheel, and a horizontal crown wheel.

To the vertical shaft is attached, by means of two cast iron jaws and bolts, a short, stout, horizontal arm, forming the axis of a heavy vertical cast iron wheel or runner, traveling round the central vertical shaft in the pan and kneading the dough by the exertion of its own weight.

Generally, in machines for this purpose, rollers with rough or mutilated surfaces are used, and friction is greatly made use of; in this case, the surface of the runner being very smooth, the effects of the weight of the runner are utilized only. It is consequently very heavy, weighing, generally, about 8,000 pounds.

When the dough is ready, it is transferred to the press (Fig. 2). These presses possess interchangeable moulds, and, consequently, macaroni, etc., of all forms, may be produced from the same machine. The press consists of two cast iron cylinders, of 19 inches in height, and 7·2 inches in width. They slide easily in guides, and are alternately brought in position under a vertical piston fitting exactly into them, which presses the dough through the moulds. The macaroni formed is placed in tubs, and then removed to the drying room. One cylinder is always filled while the other is being emptied by the piston. Thus no time is lost during the entire operation. The downward journey of the piston is slow, but much power is required for the accomplishment of the purpose, while the upward motion has to be very quick, no power being required. For this reason the manufacturers have introduced a double transmission of power. For the downward stroke a pulley of 31·6 inches in

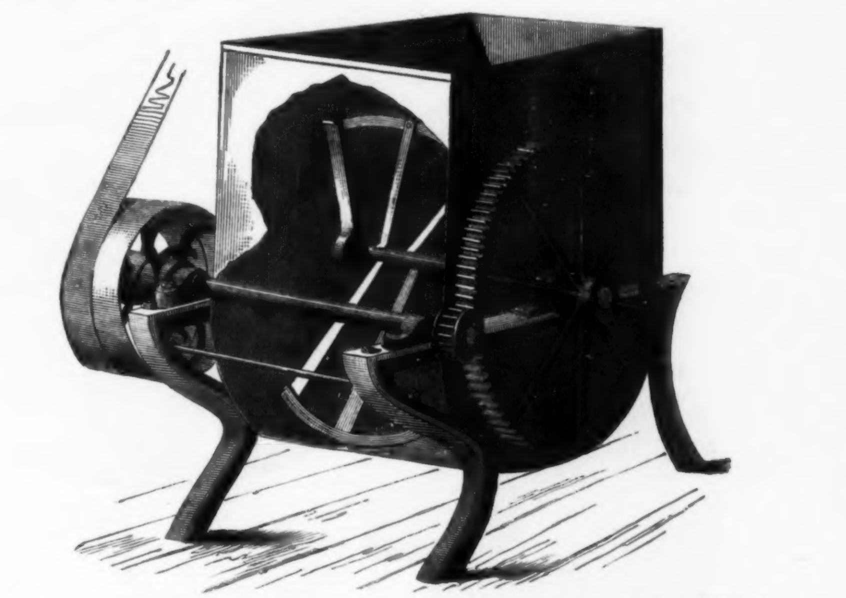


FIG. 1.—MANUFACTURE OF VERMICELLI—THE MIXER.

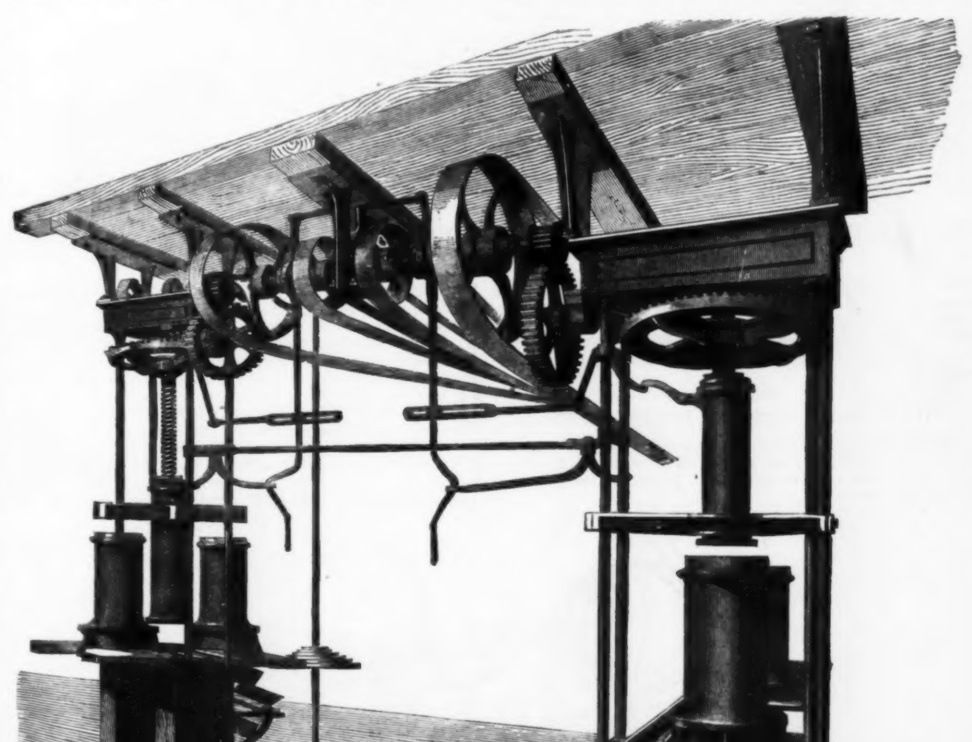


FIG. 2.—MANUFACTURE OF VERMICELLI—THE PRESS.

diameter is used, while for the upward stroke the power is transmitted to a pulley of only one half of that diameter. The piston rod moves in vertical direction only, and is provided with a screw thread.

The macaroni is delivered into the receivers by a paddle-wheel.

A press of the above given dimensions furnishes, in ten

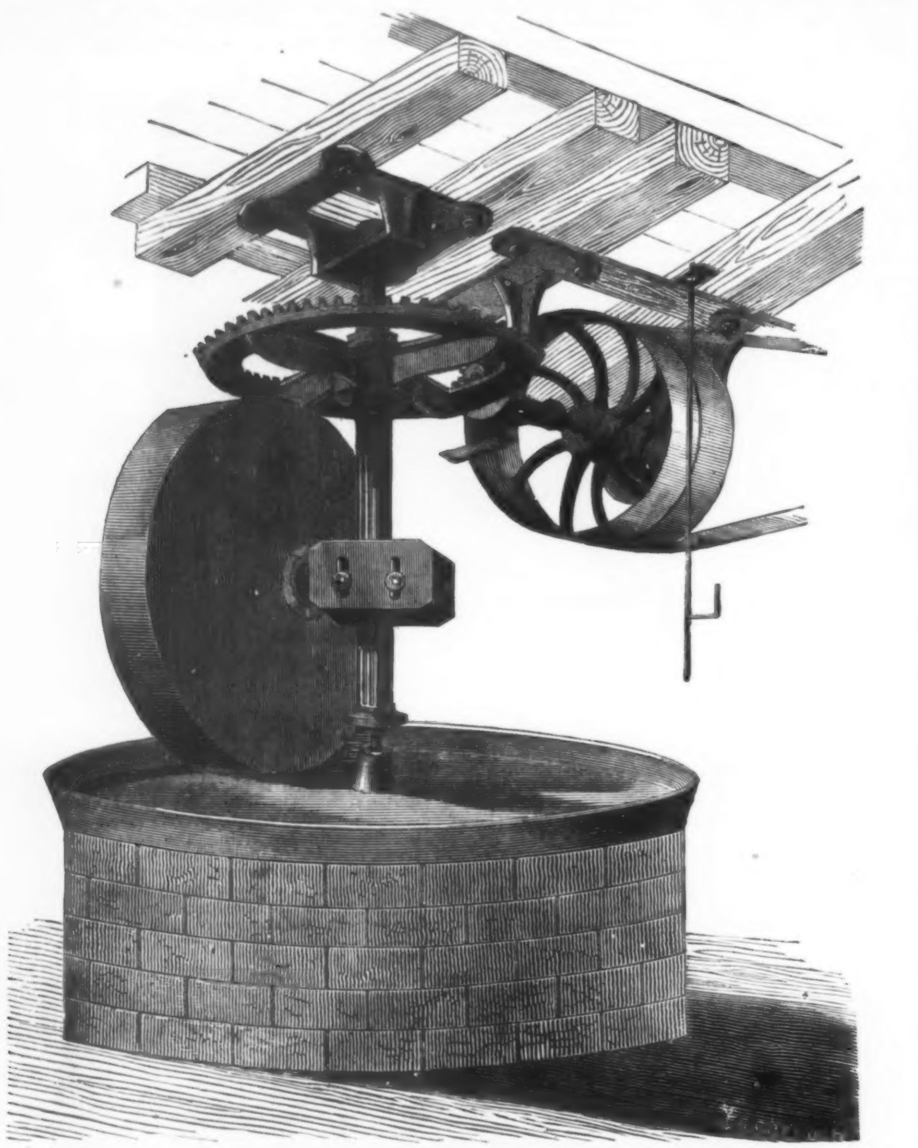
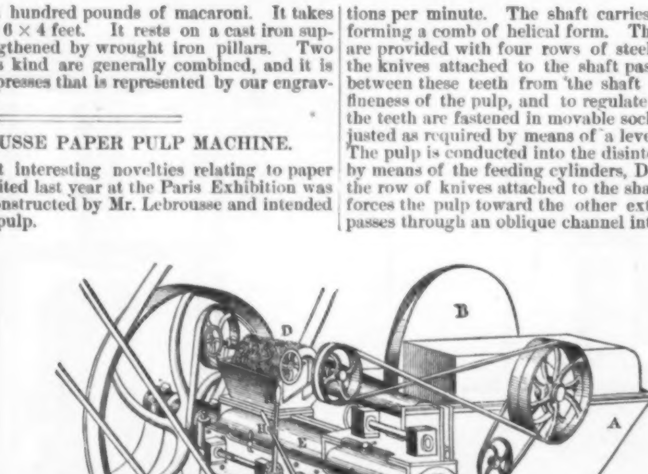


FIG. 3.—MANUFACTURE OF VERMICELLI—THE KNEADING MACHINE.

hours, about eight hundred pounds of macaroni. It takes up a space of 10 × 6 × 4 feet. It rests on a cast iron support, and is strengthened by wrought iron pillars. Two mechanisms of this kind are generally combined, and it is one of these twin presses that is represented by our engraving.

THE LEBROUSSE PAPER PULP MACHINE.

AMONG the most interesting novelties relating to paper manufacture exhibited last year at the Paris Exhibition was a pulp machine, constructed by Mr. Lebrousse and intended for making straw pulp.



THE LEBROUSSE PAPER PULP MACHINE.

It is represented by the accompanying engraving, which we copy from the *Bulletin of the Société du Musée de l'Industrie* The straw, previously cut by a special machine, and macerated in milk of lime, is conducted to the reservoir, A, in which a wheel, B, revolves and keeps the mixture of straw and water in constant motion, while the heavier substances accidentally contained in the mass collect at the bottom and may be removed through the door, C. The mixture of straw and water passes over an endless band of sheet metal, plunging into the mass in oblique direction, to a large, hollow, perforated cast iron cylinder; in passing over this the mass is drained, and it is now conducted to the disintegrator, D. It consists of a hollow cast iron cylinder, in which a shaft revolves at a velocity of 120 revolutions per minute. The shaft carries a number of knives, forming a comb of helical form. The walls of the cylinder are provided with four rows of steel teeth, between which the knives attached to the shaft pass. Upon the distance between these teeth from the shaft depends the degree of fineness of the pulp, and to regulate this distance properly, the teeth are fastened in movable sockets, which may be adjusted as required by means of a lever, H, and an eccentric. The pulp is conducted into the disintegrator at its extremity by means of the feeding cylinders, D. The helical shape of the row of knives attached to the shaft of the disintegrator forces the pulp toward the other extremity, from which it passes through an oblique channel into the refiner, or, as the inventor has termed it, the centripedal defibrator. It consists of a drum, K, containing two circular plates. One of these is immovable, and provided with five rows of conical cullers; the other, revolving with a velocity of 500 revolutions per minute, carries six rows of knives, which by their peculiar disposition force the pulp from the circumference toward the center of the drum. The movable disk is, with its shaft, adjustable, so that the distance between the knives may be regulated at will. The pulp flows through a central opening, L, to the reservoir from which is fed the paper machine proper.

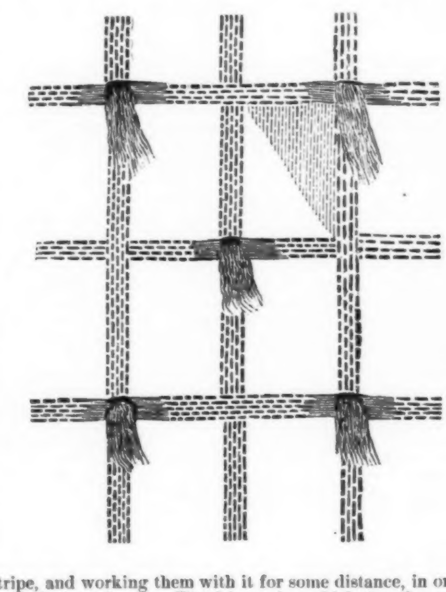
As is seen from the illustration, the machine is operated by belts and pulleys. The movable parts rest on a stout cast iron plate supported by stone masonry. The whole occupies a space of 9 × 15 feet. The machine furnishes three tons of pulp, of any desired degree of fineness, in twenty-four hours, one attendant only being necessary. Slightly altered, the machine may also be used for old paper and rags.

DESIGNING FOR TEXTILES.

IN stripes and checks probably we have one of the earliest departures from the strictly plain, unornamented surface which we suppose characterized the first attempts at weaving. But stripes, as they are now known to us, with their distinctive and ugly lines, are anything but artistic productions. When used as covering for the human body, their huge subdivisions serve to break up and disperse the beautiful lines which belong to every well-dressed form. An absurd effect of either unduly lengthening or shortening the figure is brought about, and attention is centered at once in the flaring antagonism of line and color rather in the grace and elegance of the form itself. We give preference then to flowing lines, which should be the conspicuous features of all ornamented goods intended for clothing. But though we are thus adverse to checks, we do not by any means say abolish box-looms, which would be more than ever required under new and more artistic methods of decoration. Checks, if so we may term them, made from the tones of some tertiary or neutral colors, with waved lines worked over them by the harness, and here and there perhaps a speck of bright color for relief, are quite permissible.

Variety of ground in mixed effects, or a pleasing background, whereon to work what would be otherwise startling figures, may be attained in this manner. The main object is to gain unity, and discard contrariety in the arrangement of such patterns. Both ground and figure must tend to support each other in depicting the central idea of the ornament, and not destroy the general effect by each proceeding in a contrary direction.

Below is a design requiring a box loom. The tufted spot is made by drawing some twenty or thirty extra ends of worsted in along with the ground warp, in the form of a



stripe, and working them with it for some distance, in order to bind them firmly. The faint stripe which they form, indicated by the dotted lines, is then brought to the top, and floated about three-quarters of an inch, and cut while the piece is being woven. Besides this, we employ some tufted or chenille weft for a checking, worked so as to fall close to the tufted spot, and form a sort of background to it. The remaining portion of the check is floated in small floats at the back of the piece, so as not to interfere with the firmness of the cloth, while at the same time showing as little checking on the surface as possible. The weft check differs from the warp stripe, in so far that being thicker material the floats at the back are larger than those at the back of stripe; and whereas the warp stripe is floated on the face, and cut to form the tuft, the weft is floated on the surface for same purpose, but is not cut. The appearance of subdued checking caused by the binding in of the check and stripe floats may be obviated by sprinkling the ground with granite print, to match the colored threads in stripe and check. This is illustrated in the dotting of the upper diagonal half of one of the checks in the accompanying drawing. The make of cloth may be 56 reed, with stripe extra, 2-60's cotton warp, 15 picks, 32's worsted weft, with a tolerably thick thread of worsted for stripe, and a still thicker thread mixed weft for check. For the ground, plain weaving should be employed. As an example of coloring, we might adopt one out of a range of neutral shades for ground. The object now is to place the tuft and spot on it in such colors as will give the idea of a piece of moss clinging to its root of earth. We dress the worsted stripe end for end, from three colors—viz., sap green, full green, and yellow green, which makes the moss. Then we proceed to put in the checking spot, which is composed of two shades of brown. The work is completed by subjecting the piece when woven to the action of a raising gig, while in the finishing process, in order to fluff up the mossy effect.

The swivel mode of weaving spot figures is, perhaps, the neatest and most economical when the goods are in expensive material. But as the swivel entails considerable mechanism, and affects the speed of the loom, it is probable that, in making goods from worsted or cotton, the process above explained is as cheap in the end, and very nearly as effective in design, if care be taken to hide all traces of the checking. One of the principal objects in all decoration is the embodiment of a suitable idea in the simplest manner. A little sprig, with its attendant lichen simply rendered, will carry a more pleasing emotion than all the wealth of distorted flower drawing that was ever heaped together.

The intricacies of drawing contribute far less to the ornamentation of dress fabrics than the intricacies of color. But in the latter we have amply sufficient scope for novelty, and on its successful handling depends the larger part of our future trade in fancies. We do not lack the materials required to create artistic effect; we only need to put them in work in order to attain a measure of merit equal to that reached in other branches of art work. While on the subject of color, let us see what are the relative proportions which contribute to perfect harmony. Of the primaries blue is a color of deep repose, and is marked in the chromatic scale as containing eight out of the sixteen parts required to harmonize or neutralize the three primary colors. Red possessing the greatest energy contributes five parts, and yellow, a lively color, three parts. Mixing each of these in turn with each other, in the above proportions, we get the secondary colors, which are:

Purple	made from	red and blue.	13 parts.
Orange	" "	red and yellow.	8 "
Green	" "	blue and yellow.....	11 "
			—
			32 parts.

The last named color (green) is cool and most refreshing to the human eye. It is the garb of Nature; her favorite mantle, in which she clothes field and forest, as they emerge with the young year from Winter's cold embrace. In the secondaries we have thus 32 parts, because we have doubled by admixture the several proportions of our primaries. And now for the tertiaries, which are:

Russet	made from	orange and purple...	21 parts.
Olive	" "	purple and green....	24 "
Citrine	" "	orange and green ..	19 "
			—
			64 parts.

There are now 64 parts, or double those of the secondaries. As each secondary is obtained by the admixture of two primaries, the remaining primary, if placed in juxtaposition, will produce harmony. Each tertiary being composed of two secondaries, will likewise harmonize or neutralize in contact with the remaining secondary. When complimentary colors are placed in juxtaposition they intensify each other, thus red and green, when placed together, are perceptibly stronger in tone than when looked at separately. There are many laws regarding the greater subtleties and refinements of coloring; but for the present we must content ourselves with the above, which, though elementary, may be useful to some few who have not given the subject their special study. It is certain that if we proceed to the ornamentation of any piece of fancy-dress goods, without an adequate knowledge of the different colors and their combinations, we shall have to stake our hopes of success upon the blind result of chance. The continued copying of already existing designs, so common amongst those who get all their ideas from French patterns, tends to debase the art of designing. The once beautiful forms and combinations gradually become bastardized and tortured into the most expressionless and unmeaning exaggerations. So far as he is able, the designer should go to nature for his ideas, both of form and combination. Failing this, he may study with advantage the various floral forms represented in books on botany. A bunch of grasses gracefully drooping, worked in one or two simple shades of green on a sombre ground, is quite a pleasing ornament when well handled. Even the dead oak, with its weird and leafless branches jutting out against the sky, suggests the beauty of decay. Its fork-like boughs are at any rate fine examples of nature's handiwork, and furnish the designer with several pretty specimens of branch formation. Good decoration does not require a multiplicity of patterns to copy from. They are apt to suggest monstrosity rather than beauty, and to make confusion worse confounded. To the fertile imagination familiar with nature, even "the daisy's star-shaped shadow on the naked stone" yields a delightful image, as attractive as it is simple and unembellished. It is more than likely that the furrowed bark of the forest tree, seamed with lines of unending variety, could be depicted in figured crape in many ways yet untried.—*Textile Manufacturer.*

A NEW BUCKSKIN LOOM.

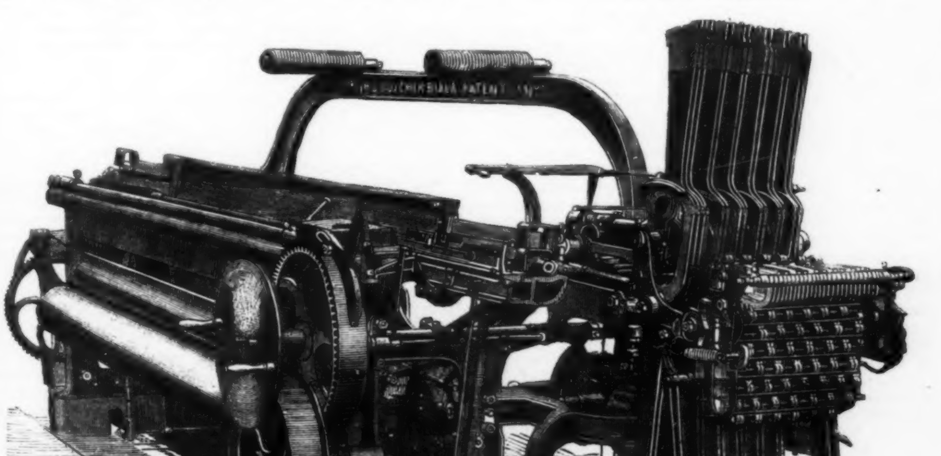
THIS loom is the invention of Mr. Robert J. Gülcher, of Biala, and, although essentially constructed analogous to the looms in use heretofore, it differs materially from them in the mode of operation of the rocking tree, the scutcher mechanism, the shuttle box, the shuttles, and the driver.

The machine is calculated for fabrics two yards in width, and works 45 wefts a minute. There are five scutchers and three shuttles and shuttle boxes on each side. The shuttles are interchangeable. The entire mechanism may be reversed for unweaving by simply pulling on the handle of a rod.

The machine is operated by an eccentric placed at the extremity of the main shaft and acting on a second shaft extending through the entire width of the loom and connected by rods with the lathe.

Simultaneously with the lathe this shaft also acts on the shuttle boxes by means of cards, which have, however, no connection with the scutchers. The latter are operated by an eccentric and rack, actuated by the main shaft. The rack engages the teeth of segments acting directly on the scutchers and also on the horizontal lifting wires. The scutchers are exchanged during the forward motion of the lathe. The cards are made of thin sheet iron, into which rectangular holes have been cut. They receive wooden pegs, united and fastened to the card by a slender iron rod. They are very light, cheap, durable, and very well adapted for the work they have to perform. The cards for operating the shuttles are of the same material and form, but somewhat shorter. When at rest, the scutchers rest on the lathe; they are raised by the pegs of the cards. The shed is quite short, and the threads from the raised as well as the lowered scutchers fall into one line. The shuttle boxes are operated by eccentrics, placed on both sides. The return motion of the driver is effected by a cylinder, sliding on a rod in front of the shuttle boxes, and moved by a lever. The shuttles are moved by spirals; the driver is of the ordinary form, but the hammer consists of two distinct portions: a tongue sitting on a horizontal axis, and pressing, when pushed forward by means of a toothed rod, on a spiral spring; the other part sits on the same axis and receives in a groove the pin of the picker or driver. The arm of the latter strikes the tongue of the hammer, presses it down, and lifts up the back part; the spiral connected with the shuttle is drawn together, and the shuttle is sent off. This is the case when the opposite shuttle box is free. If this is not the case, the toothed rod alluded to above will push the tongue forward on its axis and prevent it from being struck by the arm of the driver, and its back part remains at rest. The automatic interchange of the opposite shuttles is effected by a lever attached to the shuttle box. This lever is pushed aside as soon as a shuttle enters the box, and released again as soon as the shuttle leaves.

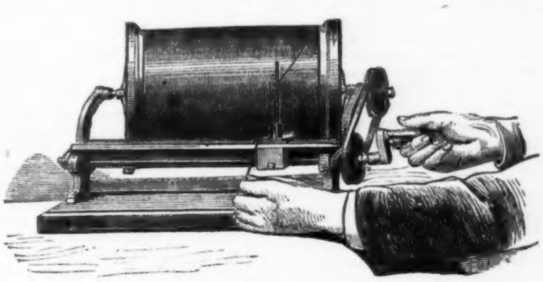
The portions of the machine coming in contact with the fabrics are constructed so as not to require any lubrication. Consequently the fabric is always clean. The machine runs very quietly; all the parts are easily accessible, and the goods produced are very solid, uniform, and of beautiful appearance.—*Zeitschrift für Textil-Industrie.*



GULCHER'S BUCKSKIN LOOM.

APPARATUS FOR TESTING THE EVENNESS OF YARN.*

THE little machine which we here illustrate has been patented in Germany, and has for its object the exposure of all

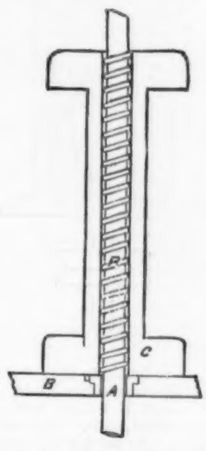


unevenness in yarn. It consists of a black board turned by a strap and pulley from a handle, which latter also revolves a screw, upon which slides a prong-shaped guide for directing the yarn as it comes from the cop, bobbin, or hank. By the revolution of this screw the yarn is wound properly spaced upon the black board, and any unevenness may thus be readily detected, as well as all impurities in the same.

The principle of testing the evenness of the yarn against black boards is not unknown to our yarn agents and shippers, but this little apparatus seems to be very handy, and to have the advantage that these boards, with the yarn, may be put aside for ready reference when required.

A DRAG FOR THROSTLE BOBBINS.*

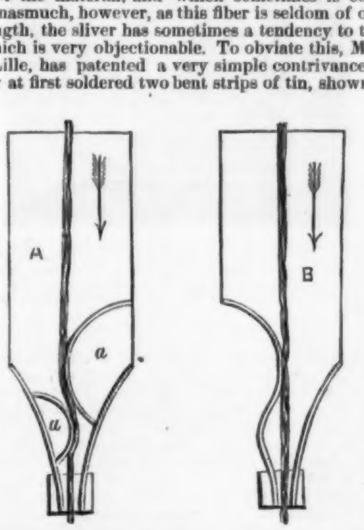
THE uncertainty with which cloth washers are supposed to act as a brake upon the bobbins used in throstle spinning and doubling frames has induced a French spinner to remove this brake action from the bottom of the bobbin to the interior of the tube, and to substitute a metallic brake for a cloth washer. The inventor places round the spindle a spiral spring, as shown in our illustration, and to prevent its turning either with the spindle or the bobbin it is attached at its



lower extremity to the spindle rail, B. The spring is sufficiently close round the bobbin not to interfere very materially with the doffing, but still exercises a gentle pressure against the inside of the bobbin. To allow room for the spring the tube hollowed out of the bobbin has to be made a little wider than usual, and this may, perhaps, weaken the bobbin too much, unless made of the very best material.

SLIVER GUIDE FOR SPINNING MACHINES.*

IN flax and jute spinning machines the sliver is generally supported between the drawing and the delivery rollers by a tin tray, in order to prevent its stretching or separating by its own weight, the length of the distance between these rollers, or what is called the "reach," depending upon the length of the material, and which sometimes is considerable. Inasmuch, however, as this fiber is seldom of one uniform length, the sliver has sometimes a tendency to twist or curl, which is very objectionable. To obviate this, Mr. Taylor, of Lille, has patented a very simple contrivance. The inventor at first soldered two bent strips of tin, shown at *a a*



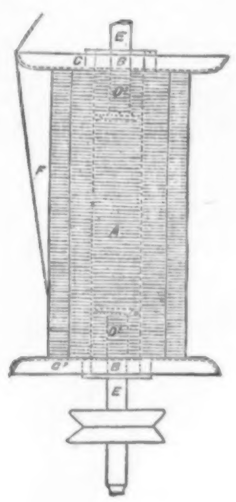
in our illustration, upon the guiding tray, but later on found it better to construct special trays with one or more bends in the ledge, as shown at *b*; this was found to offer sufficient resistance to the sliver to prevent its twisting; the number of the bends depends upon the length or regularity of the fiber. The arrangement is applicable to all stages of the spinning process where the sliver is suspended between two pairs of rollers.

WARPING BOBBINS WITH IRON HEADS.*

IT has very often been advocated by natural philosophers that when a real want for anything exists this want is soon

* The *Textile Manufacturer.*

supplied by human ingenuity, an argument which is also made use of by the opponents of patents to show that in such a case more than one inventor may hit upon the same idea simultaneously. These observations occur to us in reference to a French invention shown in our illustration, which calls to our mind the application of the same principle to slubbing tubes patented recently by Mr. Sidney Crowley, the object of which is to prevent the frequent breakages of the heads of bobbins used for winding yarn upon. The barrel, A, of the bobbin is, as usual, made of wood, but the heads are made of metal, either cast or wrought, and would now, in this country, be made of malleable cast iron.



To attach the flanges or heads to the tube a short iron tube, pointed conically, is driven into the latter, and secured to the heads by means of rings, B, driven tightly between them; the yarn unwinds, as usual, at F. It is evident that bobbins of this description, though heavier than those of wood only, must last much longer, especially as the heads of warping bobbins suffer much by being thrown about. But what about the friction of iron upon iron between the bush and the spindle? We are afraid this will be an important item.

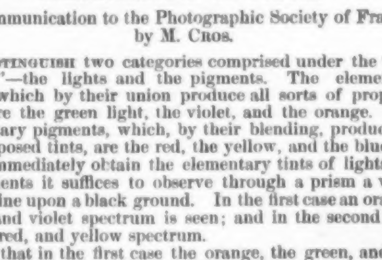
CLASSIFICATION OF COLORS

A communication to the Photographic Society of France by M. CROS.

I DISTINGUISH two categories comprised under the word "color"—the lights and the pigments. The elementary lights, which by their union produce all sorts of proposed tints, are the green light, the violet, and the orange. The elementary pigments, which, by their blending, produce all the proposed tints, are the red, the yellow, and the blue.

To immediately obtain the elementary tints of lights and of pigments it suffices to observe through a prism a white bar or line upon a black ground. In the first case an orange, green, and violet spectrum is seen; and in the second case a blue, red, and yellow spectrum.

I say that in the first case the orange, the green, and the violet are elementary lights, and in the second place the blue, the red, and the yellow are the same lights combined two and two together. The disunion of the course of the rays of the two images—one of a white bar upon a black ground, and a black bar upon a white ground in the prism—would prove this proposition; but I prefer in this short notice to demonstrate it by the apparatus which I have the honor to present to the Photographic Society of France under the name of "chromometer."



A B C, Positive images on glass obtained with different colored rays.
a' b' c', Grooves for troughs of colored liquids to be placed in conjunction therewith. D, Ground glass. E E E, Transparent plate glass screens, upon which are projected respectively the images of A B C.
S, Spectator, who sees the three images of different colors coalesced into one image.

In a box blackened in the interior I arrange three plate glasses, E E E, parallel one to the other, and forming angles of 45° with the sides of the box. The three openings, A B C, in face of the three diagonally-fixed glasses, and upon which the visual images will on examination appear united in apparently the same plane, are furnished with built-up glass-plate troughs filled with the following solutions: A red solution of chloride of cobalt, to which is added sulphocyanide of potassium; a yellow solution of neutral chromate of potash; and a blue solution of nitrate of copper. I make two troughs of each color for the three openings, A B C. I place before A the two troughs of the red solution, before B the two troughs of the yellow solution, and before C the two troughs of the blue solution. I look in front of the three diagonal glasses, E E E, and I see the three reflections, which, in combining, give white (if the amount of illumination be the same for each opening).

If I mask A, by means of an opaque screen, I have only two reflections, blue and yellow, which combine. The result obtained is white less brightly illuminated. Thus the yellow light and the blue light combined together do not give green. This fact has been already published by M. Helmholtz under analogous conditions.

If I mask B, the two reflections, red and blue, combine in one, and the tint is still white, but with a feeble trace of violet.

In masking C, white is always obtained with a rather orange tint.

When I combine the troughs in couples, yellow and blue, blue and red, red and yellow, the double media do not pass respectively, but green, violet, and orange. These three combined reflections give white as before; but if A B C are masked successively, the appearance changes altogether.

When the green is suppressed the ground assumes a pure red carmine color, such as is seen in the trichromatic spectra of the black bar upon white ground. When the violet is suppressed the ground becomes pure yellow, such as one sees in the same spectra; when the orange is suppressed the ground becomes pure blue, similarly as in the said spectra.

For a more handy presentation before the Photographic Society of France I have replaced these systems of troughs by glasses colored respectively violet, green, and orange, by means of collodion tinted with aniline colors. I have called this apparatus a "chromometer," because it can serve to distinguish the colors one from the other by numerical denominations. In fact, to vary indefinitely the tint resulting from the visible field, it suffices to vary the force or amount of lighting of each opening.

I propose to employ the method of Arago by polarized light, but I cannot afford the construction of such a costly apparatus. I must content myself with the instrument I have already had constructed, and vary the lighting by the interposition of thicknesses, more or less numerous, of transparent paper.

One of the most curious applications of the chromometer is the following: I obtain three negatives reproduced from any colored picture—the first negative through a green, the second through a violet, and the third through an orange medium. The media employed are, again, the parallel-sided flat troughs of plate glass containing standard colored solutions.

I may here remark, in passing, that the inequality of actinism of these different lights is completely compensated by various colored organic substances with which I impregnate the sensitive plates. The negatives obtained are formed of reduced silver like ordinary negatives. I obtain the black positives upon glass from the negatives, and I place each of these positives in the chromometer before the medium of the same color as that which had served to obtain the corresponding negative. I make the three reflections to coincide, and the resulting image is that of the colored model picture when the force of the three illuminations has been properly arranged.

I now add some observations upon the pigments. What is called the material "red color" is a substance which suppresses the green of white light; there only then remain the violet and the orange of the three elementary lights, of which the sum is red. In the same way the yellow pigment is that which suppresses the violet light, while the blue pigment suppresses the orange-colored light.

I have drawn the conclusion that in combining upon the same white surface the three positives in red, yellow, and blue, I obtain the primitive image of the colored model. The experience realized either by copperplate engraving or by the process on gelatine of M. Poitevin has confirmed my anticipations, which are borne out by the several specimens of the prints shown to the Photographic Society of France. —*Brit. Jour. Photo.*

PORCELAIN PAINTING.

By V. JOCLET

VIOLET colors are prepared as follows: A limpid and as near as possible neutral solution of gold in nitro-hydrochloric acid is first obtained. It is diluted with distilled water, and a solution of freshly prepared stannous chloride of spec. grav. 1·700 is added, with constant stirring, till the liquid takes a deep red-brown color; a few drops of concentrated sulphuric are then added to precipitate the suspended matter, which is then washed five or six times with fresh spring water (a very fluctuating article!), and is then, while still moist, spread with a spatula upon a plate of glass, upon which there has been previously laid a mixture produced by the fusion of 5 per cent. red lead with 2 per cent. quartz sand and 1 per cent. calcined borax. This intimate mixture of gold precipitate or lead glass is slowly dried upon the same plate in a moderately warm room, and then finely ground, still upon the plate. The proportion of the lead glass to the gold only holds good for a certain degree of heat, at which the color is burnt in upon the ware, and which is near the melting point of silver. At a lower temperature dead, brownish colors are produced. If, however, the proportion of lead glass is greater, a less degree of heat will suffice.

The above mentioned proportions give a reddish violet.

For a blue violet, 0·5 grm. of the gold preparation is mixed with 10·5 of the lead glass, and treated as above directed. The lead glass is made with 4 per cent. red lead and 1½ quartz sand. The color thus obtained can be used for modifying other blues, but it is unfit for coloring glass.

The rose shades, especially for light grounds upon porcelain, are difficult to prepare and to apply. They can only be laid on very thin, otherwise the gold is apt to separate out in the metallic state, leaving a colorless residue. Dr. Richter gives the following formula for a fine rose shade:

1 grm. gold is dissolved in aqua regia; at the same time 50 grms. alum are dissolved in 20 liters of spring water, and both liquids are mixed. The whole is then stirred while 1·5 grms. stannous chloride at 1·700 sp. gr. are added. The alumina is then precipitated with ammonia, the clear liquid is decanted off, and the precipitate is washed from seven to ten times with distilled water, collected on a filter, and dried at a gentle heat. The result is mixed with 2·5 grms. carbonate of silver and 70 grms. lead glass (prepared as for reddish violets) upon a glass plate, dried, and rubbed very fine.

Dark purple is prepared like the violets, but a quantity of carbonate of silver is added to the mixture of gold and lead glass.

For light purples, tin turnings are dissolved in boiling aqua regia, and the solution is concentrated in the water bath. The resulting stannic chloride is then dissolved in a mixture of equal parts of distilled water and stannous chloride, mixed again with water, and a clear solution of 0·5 grm. gold in aqua regia is then added. The whole is then precipitated by the addition of ammonia. If too much of this reagent is used, when a deep red coloration appears, the addition of a few drops of concentrated sulphuric acid is requisite. After washing, the preparation is mixed upon a glass plate with twenty parts of lead glass, consisting of 3 per cent. red lead, 1½ quartz sand, and 1 per cent. anhydrous borax, dried in a moderately warm place, and ground up with 3 grms. carbonate of silver.—*Chemiker Zeitung.*

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

J. P. JOULE, D.C.L., LL.D., F.R.S., etc., President, in the Chair.

Note on Certain Thionates, by E. J. Bevan, student in the Owens College. Communicated by Professor H. E. Roscoe, F.R.S., etc.

Thallium Trithionate.—When thallium carbonate is treated with an equivalent quantity of trithionic acid, prepared by precipitating potassium trithionate with tartaric acid, and the aqueous solution so obtained evaporated over strong sulphuric acid, thallium trithionate separates out in long, colorless, needle shaped crystals isomorphous with those of the corresponding potassium salt. Thallium trithionate decomposes slowly at the ordinary temperature, quickly on heating, and is with difficulty prepared free from sulphate. Analysis showed it to contain 68 per cent. of thallium, whereas the formula $K_2S_3O_6$ requires 67·95 per cent.

Hypovanadic Dithionate.—If an aqueous solution of barium dithionate be precipitated with the requisite quantity of hypovanadic sulphate, and the blue filtrate from the barium sulphate concentrated in a vacuum over strong sulphuric acid, crystals of hypovanadic dithionate separate out. If concentration be continued after the first appearance of these crystals decomposition takes place, sulphur dioxide is set free, and hypovanadic sulphate remains. This easy decomposition prevents hypovanadic dithionate being prepared in the pure state.

Aniline Dithionate.—This salt is obtained in beautiful long needles, by the double decomposition of barium dithionate with aniline sulphate. Aniline dithionate is comparatively stable; its aqueous solution may be boiled without decomposition; when the dry salt is cautiously heated in a vacuous tube it sublimes, a portion, however, undergoing decomposition. It is freely soluble in water and alcohol; 100 c.c. of water at 16° dissolve 7·89 grms. of the salt. Its alcoholic solution, treated with sodium amalgam, yields aniline sulphite. Analysis showed this body to contain 18·60 per cent. of sulphur, while $(C_6H_5NH_2)_2H_2S_2O_6$ requires 18·40 per cent. S.

On Some Improved Methods of Producing and Regulating Electric Light, by Mr. Henry Wilde.—Among the manifold functions which the elementary substance, carbon, performs in organic nature, not the least important is that by which it becomes the great source of artificial illumination, whether derived from oils, coal gas, or from coke rendered incandescent by the action of powerful electric currents. Since the time when Davy first produced the voltaic arc between two points of wood charcoal, through which was transmitted the current from the great battery of 2,000 plates belonging to the Royal Institution, many experiments have been made to determine the best kinds of carbon for developing the electric light. The carbon which, until recently, was most commonly employed for this purpose, is obtained from the sides of gas retorts, where it accumulates in the form of coke during the destructive distillation of coal. The shells of coke from the retort are sawn up into pencils from one quarter to half an inch square, and from six to nine inches in length.

Although very good results are obtained from carbon of this kind, it is a difficult material to work, on account of its hardness, and it sometimes contains impurities which interfere with its conductivity. It is also liable to fracture when suddenly heated by the transmission of powerful electric currents. These defects have led to the introduction in electric lighting of artificial carbon, composed of powdered coke and lampblack, formed into a paste with molasses and gum. This material is pressed into cylindrical forms, and subjected for a given time to a high temperature in a special furnace. The manufacture of these carbon pencils has attained great perfection in the hands of Carré, of Paris, and they can be made into perfectly straight and cylindrical forms of from two to sixteen millimeters in diameter and half a meter in length.

When the electric light is to be used for illumination, it is necessary that it should be as continuous as other modes of lighting. For this purpose not only should the current be regular in its action, but the distance between the carbon points must not alter, which necessitates the use of some arrangement for bringing them nearer together in proportion as they are consumed. Much ingenuity has been displayed by electricians in solving this problem, and the automatic contrivances invented by Staite, Duboscq, Foucault, Serrin, and others leave little to be desired in regard to the steadiness of the light, when the regulators are in good order and in the hands of intelligent operators. All automatic instruments, however, from the delicacy of their mechanism, are liable to derangement, and their action is not easily understood by persons not having a special knowledge of their construction.

To obviate the objection to the use of such instruments by unskilled attendants, I devised a few years since a regulator for use on Her Majesty's ships of war, to be actuated by hand. In this arrangement the carbons are made to approach and separate from each other by means of a right and left handed screw connected with the carbon holders. Each of the screws, with its carbon holder, can be actuated independently of the other, for the purpose of adjusting the points of the carbons to the proper focus of the optical apparatus used in connection with it. The regulator, with its carbon points, is placed in the focus of a dioptric lens, which parallelizes the divergent rays of light into a single beam of great intensity. The lens with the regulator is pivoted horizontally and vertically on the top of a short iron column fixed on a raised platform above the deck, and the beam of light may be projected upon any distant object within its range. This special application of the electric light, however, as will be seen, requires the frequent adjustment of the carbons by the operator, but as he is always required to be in attendance to manipulate the projector, no inconvenience is experienced through the absence of the automatic arrangement. This method of regulating the electric light has now been in use in the Royal Navy for more than three years, and has proved very satisfactory.

Simultaneously with the progress of improvements in the mechanism for regulating the electric light, experiments have been made with the object of dispensing with the regulator altogether. The most recent as well as the most successful of these attempts has been made by M. Jablochkoff, a Russian inventor. In the specification of his letters patent of 1877 he proposes to place the carbons side by side (as had been previously proposed by Werdermann in 1874), and to separate them by an insulating substance to be consumed along with the carbon. The inventor states that the insulating substance for separating the carbons may be kaolin, glass of various kinds, alkaline earths, and silicates,

which he prefers to apply in the form of powder, rammed into an asbestos cartridge case containing the carbons. A powder which the inventor found serviceable consists of one part lime, four parts sand, and two parts talc. These materials are rammed into the cartridge case surrounding and separating two parallel sticks of carbon placed in the case at a little distance apart. One of the carbons is made thicker than the other to allow for its more rapid waste. The lower ends of the carbons are inserted into pieces of copper tube or other good conductor, separated from one another by asbestos, and the ends of the tubes are pinched between two limbs of a screw vise connected respectively to the conducting wires.

This combination of carbons and insulating materials the inventor terms an electric candle, which, when mounted on a stand or candlestick, has the appearance of the Roman candle of pyrotechnists. The inventor further states that the heat produced by the electricity fuses the material between the carbons and dissipates it, and the freedom of the passage afforded by the fused material to the electric current permits the subdivision of the light, by placing several lamps in the course of one electric circuit. It is also stated that the construction of the candle may be varied, and, among the forms described, is one in which the carbons, instead of being contained in a cartridge case, are separated by a partition of kaolin or other similar insulating material.

I have thought it well to describe, as nearly as possible in the words of the inventor, the electric candle, which is now the subject of so much attention in its application to electric lighting, so that its relation to what follows may be more clearly perceived. A remarkable peculiarity of the direct current in electric lighting is that of its consuming the positive carbon at twice the rate of the negative one, and while the negative carbon is a pointed cone, like that of a pencil, the positive pole takes the form of a hollow cavity or crater.

M. Jablochkoff's early experiments seem to have been made with the direct current, and hence his carbons are described as being of unequal thickness in order that the positive and negative carbons of the candle might be evenly consumed. When the alternating current is used for producing electric light both carbons are of the same thickness, and are consumed at an equal rate, and both points terminate in regular cones. This property of the alternating current, besides other advantages, always maintains the luminous point in the focus of any optical apparatus used in connection with it, that is, when the carbons are placed end to end, as I had occasion to point out in a former paper, read before the society in 1873, "On an Electro-Magnetic Induction Machine for Producing Alternating Currents."

M. Jablochkoff, in the course of his experiments, would appear to have met with some difficulties in adapting the direct or continuous current to a system of lighting with his electric candles, and now uses the alternating current for this purpose. The candle has also been simplified by substituting a slip of plaster of Paris for the cartridge and partition of kaolin formerly employed.

To produce the alternating currents, however, to supply a number of lights, it was found necessary to employ powerful electro-magnetic induction machines, excited by the currents from other smaller machines, according to the principles laid down in my paper read before the Royal Society, and published in the *Philosophical Transactions* of 1867. From sixteen to twenty lights are produced from one of these electro-magnetic machines, each light absorbing about one horse power.

The system of electric lighting above described would now seem to be definitely established in some places as a substitute for gas, and visitors to the French capital during the summer will have been struck with the fine effects produced in the avenues and squares where the light is displayed.

My connection with the history of this system of lighting placed me in a position to make some experiments with the Jablochkoff candle, and led to the discovery of the following facts. One of the conditions necessary for producing a constant light from the candle, in its most recent form, was that the quantity and intensity of the alternating current should be such that the carbons consume at a rate of from four to five inches per hour. If the electric current were too powerful the carbons became unduly heated, and presented additional resistance to the passage of the current; the points at the same time lost their regular conical form. If, on the other hand, the current were too weak, the electric arc played about the points of the carbons in an irregular manner, and the light was easily extinguished by currents of air.

In the course of these experiments I was struck with the apparently insignificant part which the insulating material played in the maintenance of the light between the carbon points, and it occurred to me to try the effect of covering each of the carbons with a thin coating of hydrate of lime, and mounting them parallel to each other in separate holders, and without any insulating material between them. The use of the lime covering was intended to prevent the light from traveling down the contiguous sides of the carbons. On completing the electric circuit the light was maintained between the two points, and the carbons were consumed in the same regular manner as when the insulating material had been placed between them.

Two plain cylindrical rods of carbon, three-sixteenths of an inch in diameter and eight inches long, were now fixed in the holders parallel to each other, and one-eighth of an inch apart. The strength of the alternating current was such that it would fuse an iron wire 0·025 of an inch in diameter and eight feet in length. On establishing the electric current through the points of the carbons, by means of a conducting paste composed of carbon and gum, the light was produced, and the carbons burnt steadily downward as before.

Four pairs of naked carbons mounted in this manner were next placed in series in the circuit of a four light machine, and the light was produced from these carbons simultaneously, as when the insulating material was used between them. The light from the naked carbons was also more regular than that from the insulated ones, as the plaster of Paris insulation did not always consume at the same rate as the carbons, and thereby obstructed the passage of the current. This was evident from the rosy tinge of the light produced by the volatilization of the calcium, simultaneously with the diminution of the brilliancy of the light from the carbons.

The only function, therefore, which the insulating material performs in the electric candle, as shown by these experiments, is that it conceals the singular and beautiful property of the alternating current to which I have directed attention.

As I have already said, the strength of the alternating current must bear a proper proportion to the diameter of the carbons used, and when a number of such lights are required to be produced in the same circuit, the quantity and property of the current will remain constant, while the tension will require to be increased with the number of lights.

This simple method of burning the carbons will, I believe, greatly further the development of the electric light, as the carbons can be used of much smaller diameter than has hitherto been possible. They may also be of any desired length, for as they are consumed they may be pushed up through the holders without interrupting the light. One of these developments will be a better method of lighting coal and other mines.

In this application the alternating currents or waves from a powerful electro-magnetic induction machine may be used for generating simultaneously alternating secondary currents or waves in a number of small induction coils, placed in various parts of the mine. The light may be produced in the secondary circuits from pairs of small carbons inclosed in a glass vessel having a small aperture to permit the expansion of the heated air within. Diaphragms of wire gauze may be placed over the aperture to prevent the access of explosive gas. By generating secondary currents of waves, without interrupting the continuity of the primary circuit, the contact breaker is dispensed with, and the subdivision of the light may be carried to a very great extent.

NOTES ON THE DIFFUSION OF ATMOSPHERIC IMPURITIES IN OCCUPIED ROOMS.

DURING a discussion of certain points bearing on the subject of house ventilation, it was suggested to the writer to make some estimations of the amount of carbonic acid in the air of occupied rooms, with a view to obtaining some idea of the *diffusion* of impurities therein. Some analyses of air were accordingly made, and the results, though simply corroborating facts already well attested, may help to correct some popular notions, still quite prevalent, about the comparative purity of air in different parts of a room.

The analyses were made in March, 1877, during quite cold weather. The plan adopted was to get two samples of air from a room, one taken near the floor, the other near the ceiling, and to take the amount of carbonic acid found in each as a criterion of the impurities.

In this manner, air was examined on ten different occasions from various rooms, with the following results:

CARBONIC ACID IN VOLUMES PER CENT.

Nos.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
Near ceiling......	0·104	0·149	0·109	0·088	0·331	0·084	0·110	0·129	0·068	0·130
" floor......	0·079	0·150	0·086	0·073	0·200	0·057	0·089	0·121	[illegible]	0·148

No. 1. Air from a school room, occupied by 30 to 40 scholars; heated by stove; windows lowered slightly for ventilation.

No. 2. Air from school room; 48 scholars; occupied 1¼ hour; heated by stove; no ventilation either by open doors or windows. The two results in this case are so close as to indicate a uniform diffusion.

No. 3. Air from a school room; 40 to 50 scholars; room occupied ¾ hour; heated by stove; 3 or 4 windows had been opened at top, but were closed 5 minutes before taking samples.

No. 4. Air from a school room; 50 scholars; occupied 1¼ hour; heated and ventilated as in No. 3.

No. 5. Air from a public hall, during a dramatic entertainment; 200 persons present; room heated by a stove; occupied from 7½ to 10:30 P. M.; the only attempt at ventilation was lowering two windows slightly during latter part of evening; samples taken during dispersion of audience.

No. 6. Air of laboratory; no fire in stove, and room unoccupied; kerosene lamp standing on floor; burned 3¼ hours; temperature at top 10° Cent., at floor 8° Cent. All ventilation checked as far as possible.

No. 7. Air from parlor of private house, 10.45 P. M.; room heated by stove, and occupied till 10 o'clock P. M. by three persons; after a lapse of ½ hour, again occupied by one person, with lamp, for 15 minutes.

No. 8. Air from sleeping room, occupied 8¾ hours; not heated; all ventilation stopped except through slight crevice between window sashes.

No. 9. Same as No. 8. Ventilated by opening stove and draught into chimney.

No. 10. Same as No. 8. No ventilation.

For the sake of comparison with out-door air, the amount of carbonic acid in pure country air may be taken at 0·040 per cent.

It will be seen that in the above cases, whenever fresh air was admitted into the apartments, the air at the floor was purer than that above; also (except in No. 2) that without admitting fresh air, if there were warm ascending currents from stoves or lamps, the air was purest below; and further, although in most cases there are considerable differences in the amounts of carbonic acid, the results illustrate well the *rapid* diffusion of gases.—*F. H. W.*

CARBONATE OF AMMONIA FROM GAS LIQUOR, WITHOUT THE USE OF ACIDS.

By MR. F. W. BROTHERS.

IN July, 1875, Mr. R. O. Paterson and myself, in making some experiments, found that by a very simple process the ammonia contained in gas liquor could be formed into solid carbonate. After securing letters patent for the invention, we erected apparatus, a sketch of which is here given, to manufacture between two and three tons of carbonate per week.

As far as concerns the production of a crude sesquicarbonate of ammonia, the process employed was a perfect success, the resulting carbonate containing over 26 per cent. of ammonia. The cost of coal and labor was about £2 for each ton of carbonate produced.

The anticipations that this crude carbonate might, by sublimation and treatment with charcoal, be converted into the ordinary sesquicarbonate of ammonia, have not been realized.

The apparatus, as will be seen, is of simple and inexpensive construction. It consists of a balloon shaped boiler, connected by a Liebig condenser to a wrought iron receiver. At the outlet of the receiver is placed a water bath, and connected to the bath is a furnace to consume the sulphureted hydrogen. There is also a second boiler used, to treat the liquor after it has been treated in the first.

In order to prevent any liquid from entering the receiver, in case the liquor should boil over, a catch or intercepting box is placed at the inlet to the receiver. This box is constructed with a diaphragm, and is connected by a return pipe to the boiler. A thermometer is placed at the inlet to the receiver. Liquor being run into the boiler, heat is applied, preferably by means of a steam coil. The sulphureted hydrogen and carbonic acid gases, together with the ammonia and aqueous vapors, pass up the Liebig condenser, which is so constructed, and subjected to such control, that the excess of aqueous vapor condenses, and falls back again into the boiler. The gases pass into the receiver, together with aqueous vapor sufficient to form, with the carbonic acid and the ammonia, solid carbonate on the inside surface of the receiver. The carbonic acid being in excess, breaks up any sulphide of ammonium, and forms carbonate, the sulphureted hydrogen passing through the receiver into a furnace, where it is consumed.

The liquor, after the gases have been driven out of it in the first boiler, is run into a second, where the remaining ammonia which it contains is driven out, condensed, and used to purify the gas, and again becomes carbonated.

It appears to me that such a sure, easy, and cheap method of working up into solid carbonate the ammoniacal liquor in gas works abroad should recommend itself to the gas profession, and especially as the carbonate would find a ready market in England for the manufacture of sulphate of ammonia. In future, therefore, there need be no occasion for the great waste of ammonia at works where acids cannot be obtained.—*Journal of Gas Lighting.*

STEELING COPPER PLATES.

By R. BOTTGER.

ONE hundred parts of ammonio-ferrous sulphate and 50 parts of ammonium chloride are dissolved in 500 parts of pure water, a few drops of sulphuric acid are added, the liquid is maintained at 60° to 80°, and the copper plate is immersed in this liquid, and is made the cathode of a system of two or three Bunsen's cells, the anode consisting of an iron plate equal in size to the copper. In a few minutes the copper plate becomes covered with a hard steel-like deposit of iron.—*Chem. Centr.*

PLANTE'S SECONDARY BATTERY.

ACCORDING to Planté, if two spirals of thin sheet lead immersed in dilute sulphuric acid are connected with the wires from a battery, the anode spiral becomes covered with lead peroxide, and the cathode with a gray compact film. If the battery be disconnected when oxygen begins to be evolved at the anode, the lead spirals act as a powerful battery, and retain their electromotive force for some days. M. Böttger finds, however, that the electromotive force diminishes rapidly, and that after twenty-four hours no further action is obtainable from such an arrangement.

LIQUID CARBONIC ACID FROM BICARBONATE OF SODA.

BICARBONATE of soda is decomposed by heat, losing one equivalent of carbonic acid and water. This decomposition takes place even under a very high pressure, and on this circumstance Mr. H. Beins bases the manufacture of compressed and liquid carbonic acid for industrial purposes. The bicarbonate is heated in a retort, formed by two concentric iron cylinders, placed in a furnace, the heating gases of which pass through the hollow space inclosed by the inner cylinder. The retort communicates by a pipe with a vessel, in which the water condenses, and from here the gas is conducted into a stout cast iron recipient, tested to a very high pressure, in which, as the pressure increases, the gas liquefies. The carbonate remaining in the retort may again be converted into bicarbonate in the ordinary manner. The presence of carbonic acid may be regulated at will. Mr. Beins proposes to use liquid or compressed carbonic acid, which may easily be obtained in larger quantities in this manner, for locomotives and other machines.—*Chem. Notizblatt.*

A NEW DEVICE FOR MAGNETIZING COMPASS NEEDLES.

IT is important that the magnetic axis of a compass needle correspond exactly to the geometric axis. The following device may be used for accomplishing this purpose: A wooden plate, into which cavities are sunk, corresponding in form and size to and receiving the needles, is provided with two sliding bars, running parallel with the geometrical axis of the cavity taking up the needle. After the latter has been placed in position the bars are approached to it, so as to leave just enough room for the pole of the magnet used for magnetizing the needle, which is now done in the ordinary manner. If two needles are to be magnetized to

APPARATUS FOR THE MANUFACTURE OF SOLID CARBONATE OF AMMONIA FROM GAS LIQUOR.

an equal degree, as, for instance, when an astatic couple is to be made, a second pair of sliding bars may be provided, and placed at a distance corresponding to that between the two poles of the (horseshoe) magnet.—*Chem. Notizblatt.*

NOTE ON THE ABSORBING POWER OF VEGETABLE CHARCOAL.

BEING called upon as an expert before court to determine whether a certain sample of charcoal had at a certain time previous to the trial been soaked in water, Jaillard made a series of experiments to ascertain how long the quantity of a liquid absorbed by charcoal remained in the pores of the same. The sample in question, and another one obtained from the same kind of wood, but entirely dry, were exposed to the same degree of heat for the same length of time, when it was found that both samples had lost 9·8 per cent. of water. He then prepared new samples from one piece of wood, one of which he soaked in distilled water, the other remaining dry. Both were then exposed to the air for three days, and then kept at a temperture of 230° F. for some time. On weighing them, it was found that the amounts of water lost by them respectively were equal. Experiments with charcoal prepared from different woods gave the following results:

Wood of the	eucalyptus	lost	9·22	per cent.	of water.
"	oleander	"	9·04	"	"
"	orange	"	9·90	"	"
"	olive	"	9·35	"	"
"	button tree	"	9·10	"	"
"	oak	"	9·20	"	"

It was also observed that the quantity of water contained in charcoal changes the hygroscopic condition of the atmosphere.—*Repert. de Pharm.*

INFLUENCE OF THE DIFFERENT COLORS OF THE SPECTRUM ON THE DEVELOPMENT OF ANIMALS.

By E. YUNG.

REFERRING to earlier researches on this subject, the author states that M. Beclard placed the eggs of *Musca carnaria* under glasses of different colors, and remarked that they were developed very unequally, those under the blue and violet ray being the most developed, and those under the green ray the least so. He arranges the rays, as regards the development of larvæ, in the following order: Violet, blue, red, yellow, white, green. The author has carried on for three years a series of observations on the eggs of the common and esculent frog, of the trout, and of *Lymnea stagnalis*. These eggs were placed in vessels plunged respectively into violet, blue, green, yellow, red, and white solutions, while one vessel was kept in a dark closet. Violet light accelerates the development in a remarkable manner, and is followed in this respect by the blue, the yellow, and the white. Red and green light appears injurious, as the author was not able to obtain the complete development of ova in these colors. Darkness did not hinder development, but retarded it, contrary to the results of Higginbottom and MacDonnell. The colors may be arranged in the following series of diminishing activity: Violet, blue, yellow, and white (which are nearly equal), darkness, red, and green. Tadpoles deprived of food died more rapidly of inanition under the violet and blue rays than under the others. The general mortality seemed lowest in white light.

THE government of Zurich has prohibited the use of all coloring matters containing compounds of lead, arsenic, copper, chrome, zinc, antimony, bismuth, and mercury for coloring and decorating esculents, wearing apparel, packages for chocolate, coffee, tea, chiccory, tobacco, etc., toys, covers, and cushions of children's carriages, carpets, curtains, window blinds, lamp screens, wafers, or earthenware table services. Poisonous organic matters, *e. g.*, gamboge, picric and picramic acids, and the aniline and phenol colors are not to be used in coloring confectionery, wines, liqueurs, and sirups.

GOLD and palladium are precipitated from their neutral solutions in a finely divided metallic state by a current of pure coal gas.

DYNAMO-ELECTRIC MACHINES.

By PROFS. EDWIN J. HOUSTON and ELIHU THOMSON.*

DURING the recent competitive trials made at the Franklin Institute as to the relative efficiency of some different forms of dynamo-electric machines, the authors, having been intrusted with the work of determining the relations between the mechanical power consumed and the electric and thermic effects produced, took the opportunity thus afforded to make a careful study of many interesting circumstances which influence the efficiency of these machines.

It is purposed in the present paper to select from the many circumstances thus noticed a few of the more interesting, reserving the others for future consideration.

It will readily be understood that, from the comparatively new field in which we have been working, no reliable data of the electrical work of these machines having before been obtained, difficulties constantly arose, owing to necessary conditions of operation, and new developments, as to the behavior of the machines under varied conditions, were constantly met.

A convenient arrangement of the particular circumstances we are about to discuss may be, 1st, those affecting the internal work of the machine; 2d, those affecting the external work; and 3d, the relations between the internal and external work.

The mechanical energy employed to give motion to a dynamo-electric machine is expended in two ways, viz., 1st, in overcoming friction and the resistance of the air; and 2d, in moving the armature of the machine through the magnetic field, the latter, of course, constituting solely the energy available for producing electrical current. The greatest amount of power expended in the first way was noticed to be about 17 per cent. of the total power employed. This expenditure was clearly traceable to the high speed required by the machine. The speed, therefore, required to properly operate a machine is an important factor in ascertaining its efficiency.

The above percentage of loss may not appear great, but when it is compared with the total work done in the arc, as heat, constituting as it did in this particular instance over 50 per cent. of the latter, and about 33 per cent. of the total work of the circuit, its influence is not to be disregarded. In another instance the work consumed as friction was equal to about 80 per cent. of that appearing in the arc as heat, while in the Gramme machine experimented with this percentage fell to 20 per cent. of that which appeared in the arc as heat, and was only about 7 per cent. of the total power consumed in driving the machine.

In regard to the second way in which mechanical energy is consumed, viz., in overcoming the resistance necessary to move the armature through the magnetic field, or, in other words, to produce electrical current, it must not be supposed that all this electrical work appears in the circuit of the machine, since a considerable portion is expended in producing what we term the local action of the machine, that is, local circuits in the conducting masses of metal, other than the wire, composing the machine.

The following instances of the relation between the actual work of the circuit, and that expended in local action, will show that this latter is in no wise to be neglected. In one instance an amount of power somewhat more than double the total work of the circuit was thus expended. In this instance also it constituted more than five times the total amount of power utilized in the arc for the production of light. In another instance it constituted less than one-third the total work of the circuit, and somewhat more than one-half the work in the arc.

Of course, work expended in local action is simply thrown away, since it adds only to the heating of the machine. And since the latter increases its electrical resistance, it is doubly injurious.

The local action of dynamo-electric machines is analogous to the local action of a battery, and is equally injurious in its effects upon the available current.

Again, in regard to the internal work of a machine, since all this is eventually reduced to heat in the machine, the temperature during running must continually rise, until the loss by radiation and convection into the surrounding air equal the production, and thus the machine will acquire a constant temperature. This temperature, however, will differ in different machines according to their construction and to the power expended in producing the internal work, being, of course, higher when the power expended in producing the internal work is proportionally high.

If, therefore, a machine during running acquires a high temperature when a proper external resistance is employed, its efficiency will be low. But it should not be supposed that because a machine, when run without external resistance, that is, on short circuit, heats rapidly, inefficiency is shown thereby. On the contrary, should a machine remain comparatively cool when a proper external resistance is employed, and heat greatly when put on short circuit, these conditions should be regarded as a proof of its efficiency.

As a rule the internal resistance of dynamo-electric machines is so low, that to replace them by a battery, the latter, to possess an equal internal resistance, would have to be made of very large dimensions, so that the efficiency of dynamo-electric machines cannot be stated in terms of battery cells as ordinarily constructed.

In regard to the second division, viz., the external work of the machine, this may be applied in the production of light, heat, electrolysis, magnetism, etc.

Where it is desired to produce light, the external resistance is generally that of an arc formed between two carbon electrodes; the resistance of the arc is, therefore, an important factor in determining the efficiency. To realize the greatest economy, the resistance of the arc should be low, but, nevertheless, should constitute the greater part of the entire circuit resistance.

In some of our measurements the resistance of the arc was surprisingly low, being in one instance ·54 ohm, and in another, ·79 ohm. It was, however, in some instances, as high as 3·18 ohms.

It may be noted as an interesting fact that, where the greatest current was flowing, the resistance of the arc thereby produced was low. This is undoubtedly due to higher temperature and increased vaporization from the carbons. In this latter case also the greatest amount of light was produced.

The amount of work appearing in the arc, as measured by the number of foot pounds equivalent thereto, is not necessarily an index of the lighting power. In two instances of measurement the amount of energy thus appearing in the arc was equal, while the lighting powers were proportionately as three to four. This apparent anomaly is explained by considering the resistance of the arc, it being much less in the case in which the greater light was produced. The heat in this case being evolved in less space, the temperature of the carbons, and, therefore, their light-givingpowers, was considerably increased.

A few remarks on the economical production of light from electrical current may not be out of place. The light emitted by an incandescent solid will increase as its temperature is increased. In the voltaic arc the limit to increase of temperature is in the too rapid vaporization of the carbon. Before this point is reached, however, the temperature is such that the light emitted is exceedingly intense. No reliable method of measuring the temperature of the arc has as yet been found.

A well known method of obtaining light from electrical currents is by constructing a resistance of some material, such as platinum, having a high fusing point, and heated to incandescence by the passage of a current. When platinum is employed, the limit to its increase of temperature is the fusing point of the platinum, which is unquestionably but a fraction of the temperature required to vaporize carbon. Were the falling off in the amount of light emitted merely proportional to the decrease in temperature, the method last described might be economical. Unfortunately, however, for this method, many facts show that the decrease in the light emitted is far greater than the decrease of the temperature. Most solids may be heated to 1,000° F. without practically emitting light. At 2,000° F. the light emitted is such that the body is said to be a bright red. At 4,000° F. the amount of light will have increased more than twice, probably as much as four times, that emitted at 2,000° F. It is reasonable to suppose that, with a further increase of temperature, the same ratio of increase will be observed, the proportionate increase in luminous intensity far exceeding the increase in temperature.

It would, therefore, appear that the employment of a resistance of platinum or other similar substance, whose temperature of alteration of state as compared with carbon is low, must be far less economical than the employment of the arc itself, which, as now produced, has been estimated as about two or three times less expensive than gas.

Indeed, it would seem that future improvements in obtaining light from electrical currents will rather be by the use of a sufficient resistance in the most limited space practicable, thereby obtaining in such space the highest possible temperature.

Perhaps the highest estimate that can be given of the efficiency of dynamo-electric machines, as ordinarily used, is not over 50 per cent.; our measurements have not given more than 38 per cent. Future improvements may increase this proportion. Since the efficiency of an ordinary steam engine and boiler in utilizing the heat of the fuel is probably overestimated at 20 per cent., the apparent maximum percentage of heat that could be recovered from the current developed in a dynamo-electric machine would be overestimated at 10 per cent. The economical heating of buildings by means of electricity may, therefore, be regarded as totally impracticable.

Attention has long ago been directed to the use of dynamo-electric machines for the conveyance of power. Their employment for this purpose would, indeed, seem to be quite promising. Since in this case one machine is employed to produce electrical currents, to be reconverted into mechanical force by another machine, the question of economy rests in the perfection of the machines and in their relative resistances.

In respect to the relations that should exist between the external and internal work of dynamo-electric machines, it will be found that the greatest efficiency will, of course, exist where the external work is much greater than the internal work, and this will be proportionately greater as the external resistance is greater. Our measurements gave in one instance the relation of ·82 ohm of the arc to ·49 ohm of the machine, a condition which indicates economy in working. The other extreme was found in an instance where the resistance of the arc was 1·93 ohm, while that of the machine was 4·60 ohms, a condition indicating wastefulness of power.

* Read before the American Philosophical Society, Nov. 1, 1878.

RADIOMETER PRESSURE.

IN some recent experiments Crookes has employed the torsion balance in order to estimate the molecular pressure within the radiometer. He finds that it varies between 7 ten-millionths and 9 four-millionths of an atmosphere.—*Comptes Rendus.*

DU FAY'S THEORY.

THE difference in the electric action of excited smooth glass by dry silk, and that of sealing wax, etc., by fur, woolen cloth, etc., was discovered by M. Du Fay, intendant of the French king's gardens, about the year 1733, who, in consequence, introduced the terms *vitreous* and *resinous* electricity. After describing some other of his discoveries, Du Fay proceeds to describe the one in question in the following manner: "Chance has thrown in my way another principle, more universal and remarkable than the preceding one, and which casts a new light upon the subject of electricity. The principle is that there are *two kinds* of electricity, very different from one another, one of which I call *vitreous* and the other *resinous* electricity. The first is that of glass, rock crystal, precious stones, hairs of animals, wool, and many other bodies. The second is that of amber, copal, gum lac, silk, thread, paper, and a vast number of other substances. The characteristics of these two electricities are that they repel themselves, and attract each other. Thus a body of the vitreous electricity repels all other bodies possessed of the vitreous; and, on the contrary, attracts all those of the resinous electricity. The resinous also repels the resinous, and attracts the vitreous. From this principle one may easily deduce the explanation of a great number of the phenomena, and it is probable that this truth will lead us to the discovery of many other things."

SPECTROMETRIC MEASUREMENT OF HIGH TEMPERATURES.

By A. CROVA.

THE spectrometric study of the luminous radiations emitted by incandescent bodies has led the author to the discovery of a new method of determining elevated temperatures by the analysis of the light which they emit. If we take, in the continuous spectra of light emitted by two incandescent sources, the one of known temperature, T, and the other of unknown temperature, x, two simple radiations of very different wave-lengths, λ and λ', to which we may refer all our measurements, and determine by means of a spectro-photometer the ratios—

$$\frac{I}{I'} \text{ and } \frac{i}{i'}$$

of the intensity of the two rays λ and λ' in the two spectra. The quotient of these two ratios represents the ratio of the intensities of the ray λ', in the two spectra when the more intense has been lowered so as to give the same intensity to the ray λ in the two spectra.

PHYSICAL SOCIETY, LONDON.

On a Condenser of Variable Capacity.—Professor Guthrie read a note by Mr. C. Boys. This condenser was designed for use in connection with the Holtz electrical machine to show the effect of condensation on the length of the spark. It consists of a test tube coated externally with tin-foil to form the inner armature, and a glass tube inclosing the test tube, and having its outer surface covered with tin-foil for the outer armature. The inner tube can be slid out or in along the length of the external tube, and the capacity thereby varied. Professor Guthrie showed that a spark from the Holtz machine could by its means be gradually reduced.

Professor Macdonnel stated that he had for some years used a similar apparatus, the inner coating, however, being strong sulphuric acid.

Differential Thermometer.—Dr. O. J. Lodge exhibited a differential thermometer in which saturated water vapor takes the place of air or other gas. This application is based on the fact that the pressure of a saturated vapor in contact with its liquid depends only on the temperature. An ordinary cryophorus answers the purpose when held so that the water occupies part of one bulb and a part of the stem next it; the greater the length of the water column in the latter, that is, the more horizontal the cryophorus is held, the greater the sensitiveness of the instrument. When both bulbs are at one temperature the water in tube and bulb is at one level. If, now, there be a difference of temperature between the two bulbs, there will be a difference of pressure in the vapor in their interiors, and the level of the water will change until the pressure is equilibrated. Unlike

air thermometers, the sensitiveness does not depend on the size of the bulbs or tube, and there is no increase of volume of the vapor.

Another form consists of a U-tube with bulbs at the end of each arm, each bulb having some liquid, and the bend of the tube containing a short column of it, or, for greater sensitiveness, a series of films across the tube like diaphragms. This thermometer is found to be correct for temperatures below that of the ordinary temperature of the water and vapor, but inexact for high temperatures. With these latter the vapor tension is not the same throughout the tube, and distillation is set up. The instrument is a much more sensitive thermoscope than the air thermometer, and there is almost no limit to its sensitiveness to low temperatures. The radiation from the hand held six inches from it sensibly affects it, as also does the radiation from a piece of ice. For class purposes it is likely to be useful from its simplicity and range of delicacy.

[Continued from SUPPLEMENT 169, page 2698.]

ARCHÆOLOGICAL EXPLORATIONS IN TENNESSEE.*

By F. W. PUTNAM, Curator of the Peabody Museum.

ON the southern side of this mound, owing probably to its being always comparatively dry, the pottery was in a better state of preservation, and numerous perfect specimens were obtained from the graves. In two instances, one on the southern, and the other on the western side of the mound, there were double graves. That is, two bodies had been placed in a grave of the usual length, but wider than ordinary. In one of these, the skeletons were extended at full length and crossed each other, the skulls being at opposite ends of the grave. In the other the skeletons were side by side, but one of them was without the bones of the feet.

In several instances the skeletons in graves, which were about two feet square, were those of adults, and showed by the compact arrangement and confusion of the bones, which were out of all natural connection, that the bones must have been buried after the flesh had decayed. Such instances were probably the burial of bones brought from some other place.

Several bones collected in this mound show the effect of disease of some kind, and are such as would be generally called syphilitic; but several pathologists who have examined them unite in stating that they do not prove the existence of syphilis, as other diseases than syphilis might leave such effects.

The following summary of the collection obtained from this mound, in which about two hundred and fifty persons had been buried, will convey an idea of the contents of the

FIG. 8.—JAR FROM STONE-GRAVE MOUND, MISS BOWLING'S FARM.

graves, and I may add that the other mounds on Miss Bowling's farm yielded a corresponding amount of material of the same character:

Portions of fifty-four different skeletons, including many long bones of arms and legs, six sets of pelvic bones, and twenty-five skulls; twenty-four whole or nearly perfect vessels of pottery, nine lots of fragments of pottery from the

are much ruder than others. It is usually of a dark gray color, and composed of clay mixed with finely pounded muscle shells. As a rule, very little attempt at ornament was made on the vessels from this mound and others adjoining, and only one of the peculiar human shaped vessels, so characteristic of the pottery of this class, was found in the mound. This water vessel, or "idol," as these vessels

FIG. 9.—JAR FROM STONE-GRAVE MOUND, MISS BOWLING'S FARM.

representing the human form have been designated, is of special interest from its very rudeness of construction and the manner in which the hair, or head-dress, is represented. The two views of this vessel (Figs. 6 and 7), representing the front and profile, of natural size, give a far better and more accurate idea than could any description. As will

FIG. 6.—JAR FROM STONE-GRAVE MOUND, MISS BOWLING'S FARM. NATURAL SIZE.

FIG. 7.—SIDE VIEW OF FIG. 6.

The finding of two distinctly marked forms of crania in this mound is interesting, and of course suggests the very probable reception into the tribe of persons of another nation. The collection of crania from this mound, and other stone graves, seems, to me, to show that while the ordinary form of the crania of this stone grave people was such as would bring them among the short headed nations, they were, by intermixture with a long headed people, often of the orthocephalic type, though individual variation would also cause many heads of a purely brachycephalic nation to pass into the orthocephalic. The presence of several dolichocephalic crania among the others that were collected from the stone graves, furnishes data suggesting the intrusion of that form.

graves, fifty-nine pieces of considerable size picked out of the dirt outside of the graves; nine stone implements from the graves and seventeen outside of them; eight lots of flint chips from as many different graves; two awls made of deer's horn, four made of bone; four teeth of animals, two of which were perforated for suspension; two shells of turtles; one wing bone of a bird; one animal bone; all from graves; six spoons made out of shells of fresh water muscles (*Unionidæ*), thirty shells of Unionidæ and five lots of *Melania;* two lots of small shells, *Olivella*, perforated; four small lots of shell beads, all from graves; one pipe made of pottery, from a grave; two rings made of stone, found in one grave, and one made of pottery, found in another.

The pottery is generally well made, though some vessels

be noticed in Fig. 7, the opening of the vessel is at the back of the head, and the woman is represented as resting on her knees. This rude attempt in plastic art must not be considered as a fair example of the artistic capabilities of this people, for there are several other vessels modeled after the human form, in the collection from Tennessee now in the Museum, and among them is not one so rude and uncouth as this.

In direct contrast to this grotesque figure are the two beautiful and symmetrical vessels here represented (Figs. 8 and 9), of one-half their diameter. These jars are made with care and skill; their good proportions and well made curves equaling and closely resembling in outline some of the best of the early forms of the Old World which were pro-

duced by the aid of the wheel, while their very simplicity is perfection of the art. Smooth and well finished, and standing firm and steady, they are in every way superior to the usual vessels of this character which have been taken from

Fig. 10.—VESSEL FROM STONE-GRAVE MOUND, MISS BOWLING'S FARM.

the graves and mounds of the Southwestern States, as shown by the two annexed examples of the ordinary type (Figs. 10 and 11). The vessels represented by Figs. 8, 14, and 15, were taken from graves in mound 2, on Miss Bowling's place; all the other figures here given represent those found in graves in the mound of which special mention has been made previously.

Fig. 11.—VESSEL FROM STONE-GRAVE MOUND, MISS BOWLING'S FARM.

Another and very common form of vessel from the stone graves is represented by Figs. 12 and 13. These are comparatively well made cooking pots, furnished with holes, through which strings were probably passed, by which the vessels could be suspended.

By far the most common of the vessels found in the

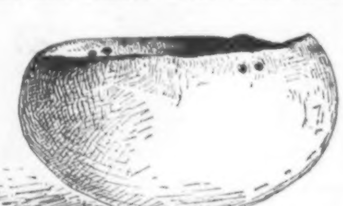


Fig. 12.—VESSEL FROM STONE-GRAVE MOUND, MISS BOWLING'S FARM.

graves are cooking pots, of various sizes, furnished with two handles. Many of these are rudely made, and resemble the two toy vessels which are shown, of actual size, in Figs. 14 and 15. Others are nearly symmetrical and of more graceful shape, as shown by Figs. 16 and 17. Still better,

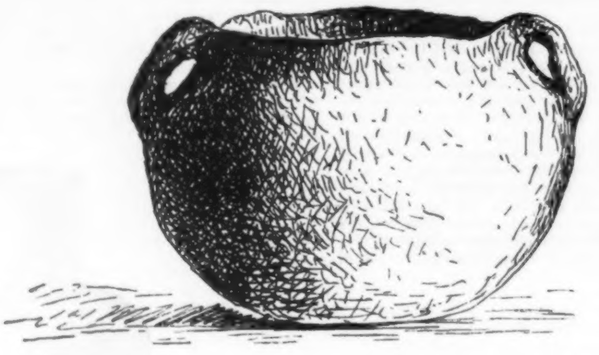


Fig. 15.—VESSEL FROM STONE-GRAVE MOUND, MISS BOWLING'S FARM. NATURAL SIZE.

and exhibiting a higher degree of workmanship, is the one represented in Fig. 18.

Fig. 19 expresses an early style of ornamentation, consisting of a line of punctures, which give relief to the waved outline of the body of the vessel where it joins the neck.

Fig. 20 illustrates a form of vessel of which we have numerous examples, showing the peculiar method of orna-

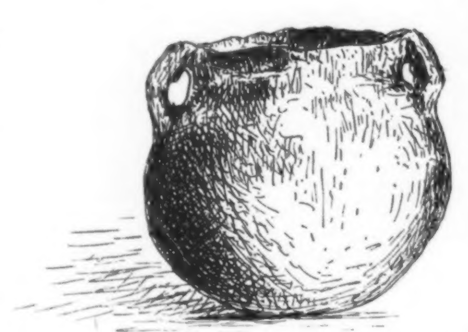


Fig. 14.—VESSEL FROM STONE-GRAVE MOUND, MISS BOWLING'S FARM. NATURAL SIZE.

mentation by pinching up the clay, in a regular manner, so as to form a series of little knobs, in this case arranged around the body of the vessel just below the neck.

Other forms of vessels were also found in this mound, some of which were dish and bowl shaped, like those figured farther on from the Lebanon mound, and the one from Mr. Overton's, represented by Fig. 2, which is a common shape. Among the fragments from outside the graves, and particularly in the ash bed, were several of a thick and rude character, evidently of large cooking pots.

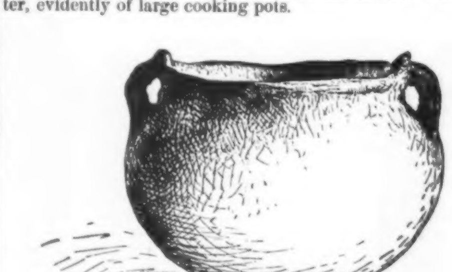


Fig. 16.—VESSEL FROM STONE-GRAVE MOUND, MISS BOWLING'S FARM.

With these articles of pottery should be mentioned the ring made of the same material, which was found in contact with an under jaw, in one of the graves; also the pipe, of which Fig. 21 is a representation of full size. This was the only pipe found in the mound, and only two or three others, all of this material and shape, were obtained from the other mounds on Miss Bowling's farm.

Among the articles of special interest found in the graves were three rings of nearly uniform size, though made of different materials. One of these (Fig. 22) is made of a hard, green steatite, and is represented of actual size. It is perfectly symmetrical and highly polished, one and three-

Fig. 18.—VESSEL FROM STONE-GRAVE MOUND, MISS BOWLING'S FARM.

quarter inches in diameter and three-quarters of an inch wide. As shown by the figure, the central portion of the outer surface is cut out so as to leave a ridge around each edge. The inner surface is slightly convex, the edges being rounded outward. A similar ring of steatite of about the same size, from Pennsylvania, has been figured by Mr. Rau,

Fig. 19.—VESSEL FROM STONE-GRAVE MOUND, MISS BOWLING'S FARM.

and a few others, made of various materials, have been found in mounds and on the surface. The specimen here figured was in close contact with the under jaw of the elderly person buried in the grave, and in the same grave, near its center, was another ring made of slate. This second specimen

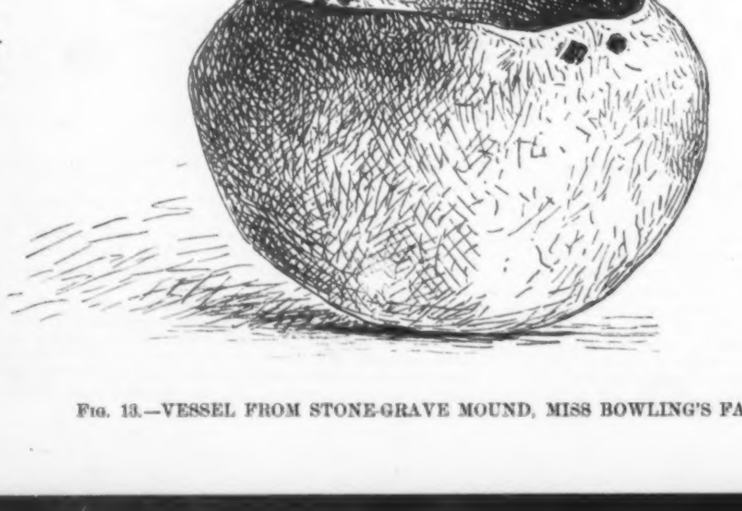


Fig. 13.—VESSEL FROM STONE-GRAVE MOUND, MISS BOWLING'S FARM.

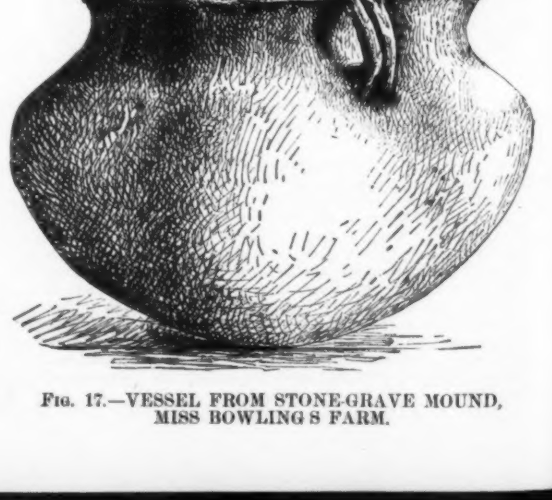


Fig. 17.—VESSEL FROM STONE-GRAVE MOUND, MISS BOWLING S FARM.

is one-eighth of an inch less in diameter and in width than the one made of steatite, and differed from that simply in not having the projecting rims, it being perfectly flat and smooth on its outer surface.

The third example of these rings is made of well burnt pottery, and while it is of the same external diameter as the one made of steatite, the thickness is slightly less. The width is the same as the one figured, and its outer surface

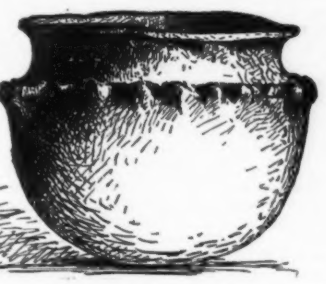


FIG. 20.—VESSEL FROM STONE-GRAVE MOUND, MISS BOWLING'S FARM.

is flat like the specimen made of slate. This pottery ring, like the one made of steatite, was found in a grave and close to an under jaw.

From the fact that two of the three rings were found in the position stated, it may be surmised that they were labrets, and were in the lips of the individuals when buried. Their size is not as large as some labrets that have been described as used by Indians of the northwestern coast, therefore there is no objection to the theory on ac-

FIG. 21.—PIPE OF POTTERY, STONE-GRAVE MOUND, MISS BOWLING'S FARM. NATURAL SIZE.

count of the size of the rings, although, as they were found in only two of the many graves, their scarcity indicates they were not in common use. Of course, these rings may have been for an entirely different purpose than I have suggested, and the contact of two of them with the under jaws may be accidental.

Implements made of stone, though often found on the surface in the vicinity of the old cemeteries of the Cumberland Valley, were not very abundant in these mounds, and were seldom found in the graves.

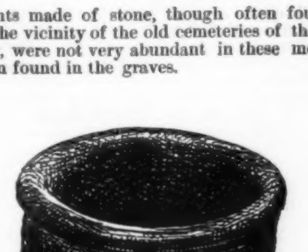


FIG. 22.—RING OF STEATITE, STONE-GRAVE MOUND, MISS BOWLING'S FARM. NAT. SIZE.

Out of thirty-one chipped implements obtained from the mounds on Miss Bowling's farm, explored for the Museum, only five were found in the graves. The position of the others among the graves, however, shows that, like many of the articles of pottery, these stone implements had been left upon or by the sides of the graves, and hence are contemporaneous with them.

(*To be continued.*)

THE DEVELOPMENT OF AFRICA.

THE urgent necessity of finding new markets for English manufactures is giving rise to numerous plans for opening up the interior of Africa to trade. A large meeting of Liverpool and Manchester capitalists considered very favorably the proposition put forth by the explorer Stanley, with regard to the construction of a railway about five hundred miles in length, from a point on the east coast to the southern end of Victoria Nyanza. This was to be supplemented by a series of railway connections between the great interior lakes and rivers. The scheme was certainly a magnificent one. A railroad 150 miles long would connect the Victoria Nyanza with Lake Tanganyika, which has a waterway of 330 miles; another railway of 200 miles would connect Tanganyika with Nyassa and its waterway. Another short railway would then reach to the navigable waters of the Shira and Zambesi, which flow into the sea—in other words, a link line of railway of 400 miles would give control of 1,300 miles of splendid navigable water.

Mr. Stanley said that the first-named railway could be easily constructed. The foundation was good the whole way, and there would be no engineering difficulties worth speaking of. Labor could be had cheap; timber was plenty, and access to some 30,000,000 people would be gained at once. The entire project would enable English merchants to reach and control the trade of over 300,000,000 people.

Meantime M. de Lesseps is urging the French Government to extend across the Sahara the system of telegraph lines which the French have already established in Tunis and Algeria. The line across Tunis now extends to Tripoli, and it is proposed to connect Senegal and Algeria by telegraph. It is reported that the Arab traders find that their camels travel much faster when following the line of telegraph posts, and the people consequently respect the wires and poles most scrupulously. The Egyptian lines now extend as far as the Equator, and with the extension of the South African telegraphs from Natal to Pretoria an impetus will be given to the scheme of carrying an overland line across the continent.

It is also reported on good authority that the British Government are about to conclude an arrangement for laying a cable to Zanzibar, Mauritius, and Natal, from Aden, where it would join the Eastern Telegraph Company's system.

POROSITY OF BUILDING STONE.

THE Buffalo *Commercial* gives the following account of an interesting experiment with building-stone in that city: "Yesterday Professor Doremus, of the Buffalo Medical College, performed a very interesting and instructive experiment before his class. A block of sandstone, such as is usually employed for window-caps and sills, and about twelve inches square and four or five inches thick, had a panel one-half an inch deep sunk in each side. In each panel was fitted a block, which was perforated by a piece of common gas-pipe, and this was cemented about the edges. The whole was then coated with an impervious varnish. Air now entering the pipe on either side had access to the clean surface of the stone beneath the panel, and it was found that if the mouth be applied to the protruding pipe on one side, and a candle be placed in front of the opposite one, it could very readily be blown out by the air, which, with very little effort, was forced through the stone. When a rubber tube was connected with the house gas-pipe on one side of the stone, and a burner was attached on the opposite side, the simple pressure from the gas mains was sufficient to force the gas through the stone till it was lit at the burner on the opposite side. When by any means the pressure was increased, a very large flame was thus produced. This shows the permeability of building stone. Brick walls and the plastering of rooms are much more porous, and it is readily seen that unglazed tile, or stone, or brick sewers afford but little security against the escape of sewer-gas."

PROFESSOR PURSER ON "TIDES AND TIDAL CURRENTS."

A MEETING in connection with the Natural History and Philosophical Society was recently held in the Belfast Museum, when Professor Purser, M.A., delivered an able and interesting lecture on the subject of "Tides and Tidal Currents." There was a large attendance of ladies and gentlemen. The chair was occupied by Robert Young, Esq., C.E., President of the Society.

Professor Purser, after a general description of the phenomena of the tides, showed that from the earliest times the inference was drawn that they were in some way or other connected with the motion of the moon. This could not fail to be so, as the period of a double oscillation of the tides weekly agrees with the period of the moon's diurnal revolution in the heavens, and the period between two of the maximum or spring tides, corresponds with the interval between new and full moon. But, although the dependence of the tides on the moon was one of the earliest physical connections observed, the *modus operandi* of our satellite remained for ages one of the great unsolved enigmas of nature. Reference was made to some of the curious attempts at an explanation of the tides before the time of Newton, more particularly some ingenious speculations of Galileo. The essential features of Newton's discovery of universal gravitation were briefly analyzed. One of the earliest and most important applications of the new theory was that to the physical explanation of the tides. These were now seen to consist in a movement brought about by the attraction of the moon on the waters, or, more correctly, by the difference of her attraction on the waters and on the solid structure of the earth. A numerical estimate of this attraction was given, bringing out into marked relief the exceeding minuteness of the tide-producing forces—forces of which yet the ultimate effects are so striking. It was explained that the tides were due, not to the vertical or direct lifting force of the lunar attraction, but to the flow of water caused by the tangential force. A tide precisely similar in character, but of smaller dimensions, is formed by the sun. It is not generally observed as a separate tide, but its effect is seen in the modifications it produces in the principal or lunar tide, and which are familiar as springs and neaps. While the tide-producing forces exercised by the sun and moon have thus been traced out by Newton's master hand, the problem of deducing from these forces the movement of the waters over the actual surface of our globe transcends the powers of mathematical analysis. That this should be so is due mainly to the following causes: The complications produced by the irregular distribution of land and water, the varying depth of the ocean bed, and the rapid rotation of the earth on its axis compelling us to treat the problem as one belonging to the *kinetics* rather than the *statics* of fluids. The following general remarks may, however, be made: High water will not occur immediately under the moon, but will follow the moon after a considerable interval. The rise of the tide in the open ocean will be very small—not more than a few inches. The ordinary tidal phenomena we are familiar with are due to the feeble ocean tide-wave being forced into narrower channels, and thus becoming greatly intensified both in elevation and rate of current. A reference was made at the close of the lecture to the interesting inquiry which has been started of recent years, whence comes all the energy which is consumed in the ebb and flow of the tidal currents? Well-known mechanical principles enable us to give a decided answer to this question. All the energy consumed in tidal friction is not imparted, as John Wright supposed, by the moon, which produces the tides, but is made up at the expense of the store of energy laid up in the rotatory movement of the earth on its axis, and must, therefore, slowly but unintermittingly reduce the speed of the earth's rotation. To form even a rude estimate of the measure of this retardation would require more accurate data than we at present possess.

[Continued from SUPPLEMENT No. 169.]

IS THE MOON INHABITED?

[FROM THE FRENCH OF CAMILLE FLAMMARION.]

ON the 7th of May (the moon four days old), I made another observation of the region of *Linné*, from 9 till half-past 10 o'clock, without being able to detect the feeblest glimmer. The brightness in the vicinity of *Aristarchus*, remarked the evening previous, kept the same intensity. The state of the sky during the evening of the 8th did not permit of any observation. On the 9th, the sky cleared up towards 11 o'clock and allowed me to make some studies. But the best evening for the point with which we are occupied was that of the 10th.

The sun, being still a few degrees above the horizon of *Linné*, lighted the east of the *Sea of Serenity* very obliquely. The little irregularities of the ground could be distinguished very perfectly. To the south, the circular craters *Pliny, Menelaus, Bessel, and Sulpicius Gallus*, showed at the same time both their relief and the depth of their central cavities. To the southeast the sun illumined the commencement of the *Apennine* chain, and to northeast made the irregular mountains of *Caucasus* stand out magnificently.

An attentive observation showed me at once that *Linné was no longer a crater!* There was no outward shadow to the east, nor any shadow in the center. In its stead, there was nothing now except a circular white cloud, or rather a white spot on the ground, and which, far from arising as a crater on the slightly greenish bottom of the *Sea of Serenity*, appeared to be neither a projection nor a hollow, but resembled a *lake*, clearer than the contiguous plain.

What had taken place? The most likely explanation is that an eruption of liquid mud had issued from the crater and had spread itself all around, forming an imperceptible declivity. Analogous phenomena are exhibited on our own earth, in connection with the mud volcanoes of the Taman peninsula, as described by Azich. The limpid mass pours out over the edges on to the dark plain, giving rise to broad band-like formations resembling haloes. However, the phenomena exhibited by *Linné* did not end with the year 1867, for the following season there was observed an orifice, which has since filled up again.

From the preceding facts it appears beyond doubt that the crater *Linné* has, in the middle of the nineteenth century, undergone an eruption surpassing in grandeur anything of a like nature which has taken place on the surface of our own globe during the same space of time. No luminous phenomena have been observed, but perhaps at this very moment there may still be resting on the summit and declivities of the crater a stratum of vapor or of mist. But here is a series of observation still more curious.

In the region of the *Sea of Nectar* it has been remarked that there existed a small crater, with a diameter of about 20,000 feet, arising, isolated, in the middle of a vast plain. Well, this crater is sometimes visible, and sometimes invisible. From 1830 to 1837 it was certainly invisible, for two observers (entire strangers to each other), Mädler and Lohrmann, examined minutely, described, and sketched this lunar region, and saw details of land just about where the crater stands—and details, too, much less important than the crater—without the least suspicion of the existence of the latter. In 1842 and 1843, Schmidt made observations on this same region without perceiving any such crater. He saw it for the first time in 1851. It can be distinguished very well on a direct photograph of the moon taken by Rutherfurd in 1865. But in 1875, the English selenographer Neison examined, drew, and described, with the minutest detail, this same spot without perceiving any trace of the volcano. At present it can be seen very well. It seems to me that the simplest explanation to account for these changes of visibility, is that at times the volcano emits smoke or vapors, which remain suspended above it and hide it from our sight; just as it would happen to an aeronaut who was sailing some miles above Vesuvius during one of its eruptions. To deny these new conclusions would be to admit that all those eminent observers, well known for the care that they have brought to their studies and for the accuracy that they have always reached, have seen incorrectly every time that the facts observed are not understood by us. This would be another hypothesis less tenable than the one of variations, which is perfectly admissible.

Can the flames of volcanoes be seen from the distance at which we view the moon by the telescope? No, not unless they burst forth with greater violence and have a more intense light than those of terrestrial volcanoes. These mists, fogs, vapors, and smoke, concerning which it becomes less and less possible to doubt, had even led Schroeter to think that their occasionally singular positions seemed to indicate some industrial origin—the furnaces and workshops, for in-

stance, of the lunar inhabitants. The atmosphere of industrial cities, he remarks, varies according to the hour of the day and the number of fires in operation. We often meet, in the works of this observer, with speculations "in regard to the activity of the Lunarians." He also believed that he had observed changes of color that might be due to modifications in vegetation or culture. Gruythuisen even believed that he recognized unequivocal traces of fortifications and of national roadways.

We will now pass on to examine the question of the probable organic state of the Lunarians—if such exist.

HAS THE MOON AN ATMOSPHERE?

We have seen that an attentive observation reveals the existence of important geological movements taking place at the present time on the surface of the lunar world, and proving that that globe, considered as a planet, is no more dead than our own. We have equally seen that certain craters, certain lunar landscapes, do not always exhibit the same degree of visibility, and are even hidden entirely at times under a mysterious vail—which vail may be either the product of smoke, or vapors, or mists; but, whatever it be, it proves that a *lunar atmosphere is not wanting*. It is proper to remark in this place that the opinion generally held as to the complete absence of a lunar atmosphere has not sufficient foundation. The only important points that the adversaries of this atmosphere can invoke (those of Bessel), simply prove that it is extremely rare, and that its density does not exceed the 200th of that which we breathe. Nor does spectrum analysis reveal traces of any atmosphere, for the spectrum of the lunar light is only a feeble spectrum of that of the sun, as if the solar rays were simply reflected by a mirror, without any modification, while planets, such as Mars, Venus, and Jupiter, add to the solar spectrum that they reflect, absorption bands produced by their own atmospheres. But spectrum analysis does not give us a proof that is sufficiently detailed, or complete enough to allow us to draw any other conclusion from it than that of the existence of an atmosphere of very feeble density. The occultations of the stars by the moon equally prove the thinness of this atmosphere, for usually the stars disappear instantaneously when the moon passes before them, and they are neither obscured nor refracted at its limb; but they do not prove its entire absence, for a great number of instances have been noted in which the occultation was not instantaneous. A comparison of these observations has even led Neison to calculate that the lunar atmosphere must weigh at least five hundredths as much as our own, and arise to a height of about 20 miles.

Indications of a lunar atmosphere has also shown themselves on following with the telescope the prolongation of the horns of the crescent during the first evenings following a new moon. It has been often remarked that the crescent continues along the edge much beyond the point where geometrically it ought to stop. This prolongation of the solar light (which has been measured on a length of more than one minute) can only be due to the effects of atmospheric reflection. Let us remark in this connection that we can observe such indications only above the edge of the moon formed by the mean height of the mountains, that is, at a great elevation above the mean level of the seas or plains, and that all these points prove nothing as to the state of the air in the lower levels. Another important remark: The density of the air on any planet whatever depends on the attraction of that planet. Every weight on the earth would be doubled if the attraction were doubled, and diminished just half if the attraction were diminished that amount, and so on. Now, this fact applies to the atmosphere as well as to any other matter. If the terrestrial gravity were reduced to that of the moon, the atmospheric pressure and the density of the air would be reduced to a sixth of their present state. A given quantity of air, at the level of the sea, would occupy more space, and the entire atmosphere would become rarefied in a corresponding proportion; it would arise to a height six times greater than at present. If, then, there were on the moon an atmosphere constituted like our own, it would arise to a height six times greater than ours, and at the mean level of the lunar plain, the pressure would be equal to a sixth of that of our air at the level of the sea. So then, even did the Lunarians have as much air per square foot as we, they would, nevertheless, have an atmosphere much more rare, and one, too, that could not be breathed by us. If we suppose, now, that it be differently constituted, and of a density six times greater than our own, it would have, on account of the weakness of the lunar gravity, only the density of that which we breathe, and would arise to just as great a height as the latter.

POSSIBLE CHARACTER OF THE LUNAR ATMOSPHERE.

Now, it may be that the moon possesses an atmosphere entirely different from ours. Our own air is a *mixture* of oxygen and nitrogen, not a chemical combination of these gases, and there is no necessity that the proportions of this mixture should be such as they are. These proportions might be entirely different in the atmosphere of another celestial body. We might even conceive of an atmosphere composed of other gases.

Carbonic acid, for instance, which exists only in feeble quantities in *our* air, might form the greater part of the composition of another. It would not be astonishing, even, did this gas (which is evolved during most operations of mineral chemistry, and especially from volcanoes) exist on the surface of our satellite, and flow towards the lowest levels, as happens here in volcanic regions, such as the *Grotta del Cane*, near Naples. This gas lasts a long time after eruption, which we may see in Auvergne. The dark and variable tint of certain circular pits, and certain valleys, very reasonably attributed to vegetation, might be perfectly explained in this way. It may be, too, that there are gases there entirely unknown to us. To sum up, then, there may (and there must) exist on the moon an atmosphere of feeble density, and probably of a composition very different from ours. Perhaps there exist certain liquids like water, but in extremely small quantity. If there were no air at all, not a single drop of water could remain there, seeing that it is atmospheric pressure alone that maintains water in a liquid state, and that without it all water would immediately evaporate. Finally, it is possible that the lunar hemisphere, which we never see, may be richer in fluids than the one that is turned toward us. But, in either case, we see that it would be contrary to a sincere interpretation of facts to assert that there is absolutely no atmosphere, nor any liquid or fluid on the surface of the moon.

Several observers have seen on the moon enigmatical lights that they have attributed to *auroræ boreales*. Thus, for example, on the 20th of October, 1824, at 5 o'clock in the morning, Gruythuisen perceived in the dark portion of the moon, while it was night on the *Sea of Clouds*, a brightness which extended as far as *Mount Copernicus*, and having a length of nearly 250 miles, and a breadth of 125. In a few minutes it disappeared, but six minutes later a pale light was seen toward the southern extremity of the preceding band, and also disappeared; then electrical pulsations succeeded each other from half past 5 in the morning until daybreak, which put an end to the observations. The observer attributed these vacillating lights to a lunar *aurora borealis*, and in this explanation there is nothing unscientific. An analogous phenomenon was seen by a friend of the astronomer Lambert, on the 25th of July, 1774.

These are so many facts which show that an attentive and persevering observation of the moon would be far from being as devoid of interest as a large number of astronomers imagine. Without doubt, as near as it is, this world differs from ours more than does the planet Mars, whose analogy with the earth is so manifest, and which must be inhabited by organisms not very different from those that go to form the terrestrial fauna and flora. But, however different from the earth, it has, none the less, its own value and originality.

THE VEGETABLE LIFE ON THE MOON.

Now, why may we not suppose that there is upon this little globe a vegetation more or less comparable to that which decorates our own? Dense forests, like those of Central Africa and South America, may cover vast tracts of territory without our being as yet able to distinguish them. On the moon there is neither spring nor autumn, and we can not depend on the varying tints of our boreal plants, on the verdure of our May and on the fall of our colored October leaves, to form a strict opinion at to whether the lunar vegetation ought to offer the same aspects, or whether it does not exist at all. There winter succeeds summer every fifteen days; during the night, it is winter, during the day it is summer. The sun remains above the horizon during fifteen times twenty-four hours; such is the length of the lunar day, and of summer; for fifteen days also, it remains beneath the horizon; such is the length of the lunar night, and of winter. The foregoing are climatic conditions absolutely different from those which govern terrestrial vegetation. In intertropical climates where there is neither winter nor summer the trees do not change their colors. We have also in our climates, plants with persistent foliage, shrubs which do not vary with the seasons; and as to the very type of vegetable verdure—the mosses of the meadows, it remains as green in winter as in summer. Now there presents itself here a series of questions, which remains without answer: Do there exist on the moon passive organisms analogous to our plants? If they exist, are they green? If they are green, do they change color with the temperature? And, if they vary in aspect, can these variations be perceived from here?

What light does telescopic observation throw on these obscure points? Certainly, there is not in the whole lunar topography any piece of land as green as a terrestrial meadow or forest; but, there are, in certain regions, distinct shades, and even changing shades. The plain called the *Sea of Serenity* presents a greenish tint traversed by an unvarying, white zone. From his observations the astronomer Klein has drawn the conclusion that the general shade, which is clearer at times, is due to a carpet of vegetation, and which, moreover, may be formed of plants of all dimensions—from the mosses and fungi up to the firs and cedars, while the ever white train may represent a desert and sterile zone. The astronomers who have most occupied themselves with lunar photography are of the opinion that the dark tint of the spots called seas must be due to vegetation, since this tint is so slightly photogenic that it scarcely makes any impression on the sensitized plate, and it requires a larger exposure to photograph the dark than it does the clear regions. This greenish shade in the *Sea of Serenity* varies slightly, and at times is very marked. The *Sea of Moistures* offers the same tint, surrounded by a narrow grayish border. The seas of *Nectar, Fecundity*, and *Clouds* do not present this aspect and remain almost colorless, while certain points are yellowish, as, for example, the crater *Lichtenberg*, and the marsh of *Sleep*. Is this the proper color of the grounds themselves, or are these tints indeed produced by plants? It is a singular fact that there are valleys and plains which change their tints with the elevation of the sun above them. Thus, the arena of the grand and wonderful circular plain of *Plato* darkens just in the measure that the sun lightens it the more, a fact which appears contrary to all optical effects imaginable. After the full moon (which is mid-summer for this lunar longitude) the surface of this plain appears in the telescope much darker than any other point of the lunar disk. There are ninety-nine chances in a hundred that it is not light that produces this effect, but the solar heat, which is not often enough taken into account when the modifications of lunar tints are studied, although it is as intimately connected with the sun's action as light is. It is highly probable that this periodic change of tint in the circular plain of *Plato* (visible every month to every attentive observer) is due to a modification of a vegetable nature, caused by the temperature. The region to the northwest of *Hyginus*, of which I have already spoken in connection with the new volcano, presents analogous variations. There are also to be seen in the vast fortified plain, baptized under the name of *Alphonso*, three spots which come out pale on the morning of the lunar night, become darker in proportion as the sun becomes higher, and become pale again in the evening at sunset. Far, then, from having the right to assert that the lunar globe is deprived of vegetable life, we possess observed facts which are difficult, if not impossible, to explain, if we admit a soil purely mineral, and which are easily explainable if we admit the existence of vegetation of some form or other. It is to be regretted that we can not analyze from here the chemical composition of the lunar earth, as we analyze that of the vapors which envelope the sun and stars; but we should not despair of success, for previous to the discovery of spectrum analysis no one had imagined the possibility of arriving at such marvelous results. However it be, we have just cause for admitting now that the lunar globe has, in former times, been the seat of formidable geological movements, all the traces of which remain visible on her troubled soil; that these geological movements are not yet over, that her seas have been covered with water, and that this water has probably not yet entirely disappeared; that her atmosphere seems to be reduced to its ultimate expression, but is not annihilated, and that the life, which for ages and ages must have spread over her surface, is probably not yet dead. The time has come to observe minutely all that is taking place on our neighboring world.

PROBABLE CHARACTER OF ANIMAL LIFE ON THE MOON.

Lunar beings and things necessarily differ from beings and things terrestrial. The moon is forty-nine times smaller than the earth, and eighty-one times heavier. Gravity at the surface of the lunar globe is six times less than at the surface of our own, so that a pound of anything transported thither would weigh there only 2·67 ounces.

The climates and seasons of the moon, too, differ essentially from ours. There the year lasts 346 terrestrial days, but consists only of 12 lunar days and 12 lunar nights, of 354 hours each, the maximum temperature, or summer, being found during the day, and the minimum, or winter, during the night, and with a thermometric difference perhaps of several hundred degrees Centigrade, if the atmosphere is everywhere extremely rare. These alone are more than enough differences to have established in the lunar world an order of life absolutely distinct from ours.

We might have before our eyes cultivated fields, plantations, roads, villages, populous cities, and (if telescopic vision should become perfect enough) even public buildings and dwellings, without having the idea occur to us that such objects were the work of the Lunarians' hands—if, indeed, they have hands. Those who stop at the real and absolute difference which exists between the moon and the earth, to deny the possibility of every kind of lunar life, and who, for example, doctorally affirm that the moon is uninhabited because her atmosphere is too rare, do not reason like philosophers, but rather like fishes. Every reasoning fish is naturally convinced that water is the exclusive element of life, and that there is no living being outside of this liquid. The truth is, an inhabitant of the moon would surely be drowned in descending into our heavy and thick atmosphere, which exerts a pressure of 33,000 pounds on each one of us here. To assert that the moon is a dead star, because she does not resemble the earth, would be the act of a narrow-minded person who imagined that he knew everything, and who dared to pretend that science had had her last say.

This lunar life cannot have been formed on the same plan as terrestrial life, because liquids, gases, density, gravity, and temperature have always been very different from what they are here. All that we can assert in regard to this old and oft debated question, as to the inhabitants of the moon, is that our satellite cannot be inhabited by beings organized according to the types of terrestrial beings. If it *is* inhabited, it is by beings absolutely different from us in organization and senses, and certainly much more different from us in their origin than are the inhabitants of Venus or Mars. It is very curious to think that, although the moon is much smaller than the earth, yet her inhabitants (if such exist) must be of a much taller stature than ours, and their edifices (if they have constructed any) of much larger dimensions than ours.

Beings of our stature and our strength, transported to the moon, would weigh six times less, while being at the same time six times stronger than we; they would possess wonderful lightness and agility, would be able to carry ten times their weight, and move masses that weigh on earth 22,000 pounds. It is natural to suppose that, not being held down to the soil as we are by gravity, they have grown to dimensions which give them at the same time more weight and more solidity, and that doubtless if the moon were surrounded by a dense enough atmosphere the Lunarians would fly like birds. But it is certain that their atmosphere is not sufficiently dense for the accomplishment of the latter organic feat.

Further, not only would it be *possible* for a race of Lunarians, the equals of the terrestrial races in muscular force, to construct edifices much loftier than ours, but it would likewise be *necessary* to give gigantic proportions to such structures, and to place them on large and massive bases, in order to secure their solidity and durability.

The inhabitants of the moon have an origin of much more ancient date than we, for the moon, although daughter of the earth, is relatively older than the latter. The geological, physical, and chemical movements that have so severely agitated her have undoubtedly been known in our contemporaneous world from the primordial genesis of her living organisms, but no observation proves that this life has in any manner disappeared.

HOW THE QUESTION AS TO LUNAR INHABITANTS MAY BE RESOLVED.

This interesting question of the moon's inhabitants might be answered, like a great many other problems of our day, by means of a powerful telescope, the construction of which would certainly not exceed a million francs ($200,000). Studies made for the purpose establish the fact that we might to-day, in the present state of optical science, construct an instrument capable of bringing the moon within a few miles, and we might even try to establish some communication with our celestial neighbors, and this would be no bolder nor more extraordinary than the idea which has given us a means of far-off communication on earth by means of the telegraph and telephone. Indeed, we may ask, in conclusion, what is the smallest object that it is possible to distinguish on the moon? The diameter of that globe is 3,475 kilometers (2,160 miles), and measures geometrically 31 minutes 24 seconds. A kilometer (3,281 feet) on the moon, then, measures 0·54″, and a second represents 1,850 meters (6,061 feet). Now, at present, according to the calculations of Professor Hall (to whom science is indebted for the curious discovery of the satellites of Mars), we can distinguish an angle of three-hundredths of a second, that is, a length of 55 meters (180 feet). We might go still farther, and distinguish an object 30 meters broad (about 100 feet). At sunrise and sunset the elongated shadow brings into relief heights of 10 meters (33 feet).

But we must conclude. Shall we remain any longer at rest before the promised land, without resolving the interesting problems that are offered to human curiosity? Are we not jealous of the wonderful conquests due to the powerful instruments of America and England? Do we, without envy, observe foreign countries supplied with free observatories, founded by private effort, due to generous protectors of the sciences, while as yet there is not a single one in France established under such conditions? Does France possess gold only for lotteries and race courses, and shall we always remain asleep on the pillar of state? A good movement, a movement inspired by the most marvelous of sciences, might endow us to-day with the most powerful telescope in the world.

Who knows? Even while I am discussing this question, it may be that some of the inhabitants of the moon are up there in their valleys, and on the velvety plain of *Plato*, gazing down upon us from their distant abode. And perhaps they have been prepared for a long time past to open a correspondence with us.

F. Rosetti has published the results of an extensive series of investigations, from which he estimates the temperature of the sun at between 12,000° and 20,000° (21,632° and 36,032° F.).—*Il Nuovo Cim.*